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RESEARCH REPORT

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COFFEE BOOM, GOVERNMENT EXPENDITURE, AND AGRICULTURAL PRICES: THE COLOMBIAN EXPERIENCE

Jorge García García
Gabriel Montes Llamas

August 1988

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CONTENTS

Foreword

1. Summary 9

2. Introduction 11

3. The Role of Agriculture in the Colombian Economy and Main Economic Developments, 1967-83 14

4. A Model and Empirical Evidence 30

5. Supply Response in Colombian Agriculture 49

6. Income Distribution and Real Wages in Agriculture 65

7. Conclusions 79

Appendix 1: Data Sources and Methods 82

Appendix 2: A Demographic Model for the Colombian Livestock Sector: 1940-75 94

Appendix 3: Supplementary Tables 98

Bibliography 101

TABLES

1. Main indicators of the role and structure of agriculture in the Colombian economy, selected years, 1967-83 15
2. Share of agricultural imports and exports in total imports and exports, selected years, 1970-83 16
3. Real agricultural exports and imports relative to the real gross value of output in agriculture, selected years, 1970-83 18
4. Real exchange rate index, relative export and import prices, terms of trade, and profitability of exporting, 1967-83 23
5. Summary balance of payments, 1968-83 24
6. Money supply, money base, and money multiplier, 1966-82 25
7. Central government operations as a share of GDP, 1966-82 25
8. Consolidated public sector revenues and expenditure, nominal GDP, and revenues and expenditures as a share of GDP, 1966-82 26
9. Domestic interest rate, devaluation, interest rate differential, and parity rate, 1967-83 27
10. Relative price index for agricultural output, 1970-83 28
11. Determinants of relative prices of noncoffee tradable and agricultural tradable commodities 41
12. Determinants of relative prices in the agricultural sector 43
13. Demand for money 46
14. Determinants of the domestic interest rate, 1967-83 47
15. Determinants of changes in international reserves and the extent of capital mobility 48
16. Logarithmic regressions for estimating the supply response of cotton 51
17. Logarithmic regressions for estimating the supply response of rice 53
18. Logarithmic regressions for estimating the supply response of wheat 54
19. Logarithmic regressions for estimating the supply response of coffee 55
20. Short-run supply elasticity of male, female, and total sales of cattle, 1945-75 58
21. Short- and long-run responses of male, female, and total cattle sales, estimated using polynomial distributed lags, 1954-75 61
22. Estimation of aggregate supply response in agriculture 64
23. Share of labor income in value added 72

24. Estimated effects of relative price changes on nonlabor income in the coffee, noncoffee tradable, and nontraded sectors, 1970-82 73
25. Logarithmic regressions for estimating real agricultural wage equations 78
26. Classification of agricultural products by categories: food and nonfood, traded and nontraded, 1970-82 86
27. Classification of processed and industrial products by categories: traded and nontraded, 1970-82 88
28. Classification of forestry, fishing, mining, and services by categories: traded and nontraded, 1970-82 90
29. Value-added and labor income by categories of importable, exportable, and nontraded sectors, 1970-82 98
30. Index of prices of gross value of output relative to prices of nontraded output, 1970-83 99
31. Index of wages, 1967-83 100
32. Population, employment by sector, economically active population, and rate of unemployment, 1965-83 100

ILLUSTRATIONS

1. Real value added in agriculture as a share of real GDP 16
2. Effects of an increase in the price of coffee 38
3. Increase in government expenditures financed by taxes 39
4. Effect of a coffee boom on the labor market 67
5. Effect of a coffee boom on the commodity market 68
6. Effects of a coffee boom when capital moves between noncoffee tradable and nontradable sectors 70
7. Sales of male and female cattle, 1940-75 96
8. Size of male and female cattle herd, 1940-75 97

FOREWORD

In this report Jorge García García and Gabriel Montes Llamas examine the effects on agricultural incentives in Colombia of two influential economic forces: the coffee boom in the 1970s and rapidly expanding public sectors. In Colombia, the turbulence in trade and exchange rate regimes brought about by the coffee boom presents a classic example of the Dutch-disease phenomenon. This report is part of an extensive body of IFPRI work on these forces, which includes an earlier study by García, *The Effects of Exchange Rates and Commercial Policy on Agricultural Incentives in Colombia: 1953-78,* Research Report 24, and others including *Agriculture and Economic Growth in an Open Economy: The Case of Argentina,* Research Report 36; *The Effects of Trade and Exchange Rate Policies on Agriculture in Nigeria,* Research Report 55; *The Effects of Trade and Exchange Rate Policies on Agriculture in Zaire,* Research Report 56; and *Production Incentives in Philippine Agriculture: Effects of Trade and Exchange Rate Policies,* Research Report 59.

In their analysis of government's expanding role as a demander of goods and services, García and Montes also examine the effects on farm output and on rural employment as they pertain to rural incomes and wage rates under the argument that government expenditure biased toward the nontraded sector discourages growth in agriculture and industry. Two earlier reports, *Government Expenditures on Agriculture in Latin America,* Research Report 23, and *Government Expenditures on Agriculture and Agricultural Growth in Latin America,* Research Report 50, relate to this work.

John W. Mellor

Washington, D. C.
August 1988

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Jorge García García
Gabriel Montes Llamas

1

SUMMARY

This report analyzes the effects of variations in the external terms of trade and in government expenditure on relative product prices, real agricultural wages, and the distribution of income between labor and nonlabor factors of production in Colombia during the period 1967-83. The Dutch disease phenomenon in Colombia resulting from the effects of changes in terms of trade has been widely analyzed in the literature. This report builds on this body of work by looking at various categories of traded goods, with emphasis on the effects on agricultural commodities. Moreover, the role of the government as a demander of commodities in the economy is incorporated and its effect on relative agricultural prices is analyzed. In addition to the direct effects of terms-of-trade changes, the report measures the impact on factorial income distribution in the traded and nontraded sectors and on real agricultural wages.

Agriculture, the most important sector of the Colombian economy, generates about 25 percent of GNP, produces about 65 percent of the domestic food supply, and earns about 65 percent of Colombia's legal foreign exchange revenues. Coffee, the main agricultural export, accounts for about half of these earnings. During 1967-74 a combination of favorable world economic conditions and moderate fiscal and monetary policies stimulated overall growth and a stable economic environment. In the mid-1970s, however, a sharp rise in the export price of coffee led to an increase in coffee production and subsequently an increase in the quantity exported.

As a result of these economic developments, the price of nontraded goods increased relative to the price of noncoffee tradables, thereby discouraging production in the tradable parts of the agricultural and manufacturing sectors. The report analyzes empirically the factors that explain the change in relative prices between noncoffee tradable and nontraded activities in general and between broad aggregates of agriculture and the nontraded goods sectors of the rest of the economy, in particular.

Changes in product prices affect factor prices and the functional distribution of income across sectors. Using a simple framework, the effect of changes in coffee prices on the income of the nonlabor factors of production is estimated, and it is found that an increase in the price of coffee tends to reduce nonlabor income and to increase labor income.

Agricultural wages are the lowest in the country. Therefore it is not possible to study the determinants of poverty in agriculture without also addressing the existence and permanence of low real wages. Wages in the cities tend to be higher, and people migrate to the urban sector with the expectation of finding a job with higher pay. The higher the rate of urban unemployment, the lower the expected urban real wage. On the other hand, the real wage that farmers will pay depends on the price of farm output and the productivity of labor. The rural wage rate is therefore affected by the rate of urban unemployment, real wages in both rural and urban areas, the size of the rural population, the productivity of labor in agriculture, and the price of agricultural products.

The empirical analysis of the determinants of real wages in agriculture finds that the size of the capital stock, higher prices of agricultural products, and a higher urban wage tend to increase real wages in agriculture, while high rates of urban unemployment and a larger population in agriculture tend to reduce them. Therefore, macroeconomic policies that depress agricultural prices work against rural laborers by reducing their real wages.

Another issue is agricultural supply response, which is estimated for the most representative products of Colombian agriculture—rice, cotton, wheat, coffee, and livestock—to determine whether changes in relative prices introduced by movements in coffee prices or in the government's expenditure policy have any effect on output. The results show that output responds to changes in prices. These findings point up the importance of price incentives in agricultural production and highlight the crucial effects of macroeconomic developments and policies in determining incentives for agriculture.

The report elaborates a consistent set of accounts for agriculture, which can help clearly establish the role of agriculture in the Colombian economy. A series of prices of traded and nontraded goods for the agricultural and nonagricultural sectors are generated, making it possible to analyze the effects of changes in coffee prices and government expenditure on relative prices among broad categories of products. Time series of total income for labor and nonlabor factors of production are constructed for noncoffee tradables, nontradables, and coffee.

Finally, the report discusses pros and cons of various policies that might alleviate eventual adverse effects on other sectors of a boom in one sector, including reducing government spending, taxing gains in the booming sector, encouraging exporters to leave gains outside the country until the boom ends, and placing a tariff on coffee, the proceeds from which would be used to subsidize other agricultural exports.

The finding that agricultural output does respond to price changes is important because it explains the decline in Colombian agriculture, which has often been blamed on the competition of imports. It also implies that spurring the economy by increasing government expenditure may not be the answer to agricultural growth because it may only serve to reduce relative agricultural prices.

2

INTRODUCTION

When a large sector of an economy expands rapidly, such as coffee during a boom period in Colombia, it draws resources away from other sectors, with consequent repercussions in relative prices, wages, distribution of income, and terms of trade. This phenomenon, called the "Dutch disease," has been analyzed for Colombia by a number of authors.[1] This report extends their analysis, examining in greater detail the effects on the various categories of traded goods, especially on agricultural commodities.

Because more than 50 percent of Colombia's legal foreign exchange earnings is derived from coffee,[2] changes in the world price of coffee profoundly affect the Colombian economy, including foreign exchange revenues, real income, and expenditures. Changes in external coffee prices also bring about changes in domestic relative prices. Changes in government policies on taxation and expenditure also alter relative prices.

Between 1967 and 1974, Colombia reduced its import substitution bias and experienced growth rates in GNP of 6.4 percent annually. Since 1975, however, economic activity has decelerated.

Two important actors in the economic development of Colombia in the second half of the 1970s were, first, the coffee boom, which started in 1975, and, with some interruption, lasted until 1980; and second, the growth of government spending and the resulting fiscal deficit, which led to the sharp deterioration of the international reserve position of the country. A third important actor was the drug boom, essentially of marijuana and cocaine. According to estimates by Hernando J. Gomez, during the period 1981-85 net income from drug traffic ranged from a low of 2.6 percent of GDP in 1985 to a high of 6.4 percent of GDP in 1982.[3]

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[1] Sebastian Edwards, "Coffee, Money, and Inflation in Colombia," *World Development* 12 (November/December 1984): 1107-1117; Sebastian Edwards, "Commodity, Export Prices and the Real Exchange Rate in Developing Countries," in *Economic Adjustment and Exchange Rate in Developing Countries,* ed. Sebastian Edwards and Liaquat Ahamed (Chicago: University of Chicago Press, 1986), pp. 235-260; Sebastian Edwards, "A Commodity Export Boom and The Real Exchange Rate: The Money-Inflation Link," in *Natural Resources and the Macroeconomy,* ed. J. Peter Neary and Sweder van Wijnbergen (Cambridge, Mass.: MIT Press, 1986), pp. 229-251; Linda Kamas, "Dutch Disease Economics and the Colombian Export Boom," *World Development* (September 1986): 1177-1198; and Carlos Diaz-Alejandro, "Latin American Debt: I Don't Think We Are in Kansas Anymore," *Brookings Papers on Economic Activity* (1984): 2.

For analysis incorporating the agricultural sector, see Jorge García García, "Aspects of Agricultural Development in Colombia: 1970-1982," paper prepared for the Colombia Division of World Bank, Bogotá, April 1983 (mimeographed); Gabriel Montes, "Políticas Macroeconómicas y Desarrollo Agropecuario," *Revista Nacional de Agricultura* (December 1984): 125-149; and Vinod Thomas et al., *Linking Macroeconomic and Agricultural Policies for Adjustment and Growth* (Baltimore: Johns Hopkins University Press, 1985), especially chapters 1-4.

[2] This figure refers to foreign exchange earnings from legal exports. Exactly how much foreign exchange is earned from illegal activities (cocaine and marijuana) and how much is brought back to Colombia through the Central Bank is not known. For estimates of the size of illegal activities and their contribution to foreign exchange revenues of the Central Bank, see Roberto Junguito and Carlos Caballero, "La Otra Economía," *Coyuntura Económica* 8 (1978): 101-141; and Hernando J. Gomez, "The Colombian Illegal Economy: Size, Evolution, Characteristics and Economic Impact," in *State and Society in Contemporary Colombia: Beyond The National Front,* ed. Bruce Bagley, Francisco Thoumi, and Juan Tokatlian (Boulder, Col.: Westview Press, 1988).

[3] See Gomez, "Colombian Illegal Economy," Table 7.

This report commits a sin of omission by leaving drugs out of the analysis. Unfortunately, the information required to incorporate it did not exist when this study was done. Even Gomez's study, which became available after a preliminary version was finished, does not cover the entire period analyzed in this report. With the drug sector left out, the impact of the coffee boom and the expansion of government expenditure may be overestimated. However, the extent of overestimation is reduced as long as the main effect of the drug boom is felt on expenditures and only a small amount of the foreign exchange earned abroad is brought into the country. In 1982, for example, when the estimated effect of the drug activity was largest—US$2.5 billion—the sale of dollars to the Central Bank from illegal activities is estimated to have been US$23 million, whereas in 1979 those sales were estimated at US$312 million, equivalent to 20 percent of the total increase in international reserves in that year.[4]

Substantial increases in the external price of coffee and later in the volume of coffee exports characterized the coffee boom. The rise in coffee prices increased the real income of most Colombians, but particularly those in the coffee sector. As a result, spending on nontraded commodities (goods produced for domestic consumption only) and on export and import-competing goods (traded commodities) increased. The higher coffee prices and larger volume of coffee exports led to a substantial accumulation of international reserves, an increase in the rate of monetary expansion, and an acceleration of inflation. The induced rise in expenditure increased the demand for all commodities (nontraded and traded), and as a result the price of nontraded commodities relative to the price of traded ones went up. Thus, the incentives to produce noncoffee exports and import-competing commodities declined, and production in the noncoffee tradable sector was discouraged.

The effects of increases in government expenditure on relative prices are not as clear as those from an increase in the coffee price because such expenditures tend to affect both nontraded and noncoffee tradable commodities. When the marginal propensity of the government to spend on nontraded goods is higher than that of the private sector, a rise in government expenditure increases the price of nontraded goods. This seems to have been the case in Colombia, where an increase in the ratio of government expenditure to the GDP caused the relative price of nontraded commodities to rise.

Turning from the effects on agricultural prices to the determinants of real wages, empirical analysis finds that a growing capital stock, higher prices of agricultural products, and a higher urban wage all tend to increase real wages in agriculture, while high rates of urban unemployment and a larger population in agriculture tend to reduce it.

Another point addressed in this report is the issue of agricultural supply response. To understand and measure properly the supply response of agricultural output, it is necessary to model the interactions between factor and product markets in a dynamic framework. Because of its complexity and data requirements, this exercise is beyond the scope of the present report. Simpler methods to analyze the supply response of agriculture are used here.

Supply response is estimated for the most representative products of Colombian agriculture (rice, cotton, wheat, coffee, and livestock). The purpose of estimating supply response is to determine whether changes in relative prices introduced by movements in coffee prices or in the government's expenditure policy have any effect on output.

One important contribution of this report is the elaboration of a consistent set of accounts for agriculture, which can help establish clearly its role in the Colombian economy. Another is the generation of a series of prices of traded and nontraded goods for the agricultural and nonagricultural sectors, making it possible to analyze the effects of changes in coffee prices and government expenditure on relative prices among broad categories of products. Finally, a time series of total income for labor and nonlabor factors of production is constructed for noncoffee tradables, nontradables and coffee, without which the analysis of the redistribution of income as the result of the coffee boom would not be possible.

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[4] Ibid., Tables 7 and 17.

3

THE ROLE OF AGRICULTURE IN THE COLOMBIAN ECONOMY AND MAIN ECONOMIC DEVELOPMENTS, 1967-83

Agriculture is the single most important sector of the Colombian economy. It generated 30 percent of the country's real gross national product (GNP) in the late 1960s and about 25 percent in the second half of the 1970s and early 1980s (see Table 1 and Figure 1).[5] The gross value of agricultural output is roughly divided between coffee (32 percent), livestock (33 percent), and other agricultural production (35 percent). Agriculture is the main source of food for the Colombian population. The gross value of food output during the period is 66 percent of gross agricultural output (see Table 1). The real gross value of food output is 2 percent higher than the net supply of food, but since 1979 that positive gap has declined. On the other hand, between 1967 and 1983 physical food output increased by 3.8 percent per year, while total apparent food consumption increased by 3.6 percent. Food output is highly diversified and stable.[6] Thus, the diversity of Colombian agriculture contributes enormously to the stability of food supply in the country.

When measured by the import-output and export-output ratios, external trade is not important for agriculture; however, most Colombian agriculture can be classified as tradable (Table 1).[7] In fact, for agriculture as a whole, agricultural output classified as exportable represents an average of 61 percent of the gross value of agricultural output, and importables represent 13 percent. This points up the close link between external events and developments in domestic agriculture. For noncoffee agriculture, the combined output of exportables and importables is, on average, 44 percent of its real gross value, out of which 32 percentage points could be categorized as exportables. Food output classified as tradable represents 41 percent and nontradables 26 percent of total agricultural output. Out of the 41 percent in the tradable category, 29 percentage points are exportables.

Agriculture was the main source of registered foreign exchange earnings for Colombia during the period. Agricultural exports were 67 percent of real exports of goods in 1970 and 65 percent in 1983, and close to 56 and 55 percent of real exports of goods and services in the same years. The average contribution of the sector to commod-

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[5] According to the definition used by DANE, agriculture is composed of three sectors: production of unprocessed "pergamino" coffee, other agricultural production, and animal production. With this grouping the agricultural sector *(sector agropecuario)* represents 22 percent of GDP. The broader definition of agriculture used in this report includes coffee processing and sugar manufacturing as part of agriculture. See Colombia, Departamento Administrativo Nacional de Estadística, División de Cuentas Nacionales, *Metodologia de las Cuentas Nacionales de Colombia-Según el Nuevo SCN (Versión Preliminar),* January 1979 (mimeographed). For a discussion of the definition of agriculture used in this report and the way the series for the agricultural sector was derived, see Appendix 1.

[6] Jorge García García, "Es Importante la Seguridad en el Suministro de Alimentos en Colombia," *Revista de Planeación y Desarrollo* (September-December 1979); and Jorge García García and Lía Guterman, "The Contribution of Food Aid to Food Security in Colombia," a paper prepared for the Food and Agriculture Organization of the United Nations, Bogotá, 1984 (mimeographed).

[7] For a definition of exportables, importables, and nontraded sectors of agriculture, see Appendix 1.

Table 1—Main indicators of the role and structure of agriculture in the Colombian economy, selected years, 1967-83

Indicator	1967	1971	1975	1979	1983
			(percent)		
Real value added in agriculture as a share of GDP					
Agriculture (01-03)	25.8	23.4	23.0	22.2	21.7
Processed coffee (08)	3.7	3.2	3.2	3.4	2.8
Sugar (12)	0.3	0.5	0.6	0.5	0.6
Broad agriculture (01-03,08,12)	29.9	27.0	26.8	26.2	25.1
Structure of real gross output					
Pergamino coffee (01)	11.1	9.2	8.5	10.4	11.8
Other agricultural production (02)	34.1	33.9	35.0	33.4	32.2
Animal production (03)	31.7	34.6	33.6	31.3	33.4
Processed coffee (08)	20.2	18.8	18.7	21.2	18.3
Sugar (12)	2.9	3.6	4.1	3.7	4.4
Total agriculture (01-03,08,12)	100.0	100.0	100.0	100.0	100.0
Noncoffee (02,03,12)	68.7	72.0	72.7	68.4	70.0
Coffee (01,08)	31.3	28.0	27.3	31.6	30.0
Tradable goods	n.a.	74.4	74.1	73.4	73.8
Exportable	n.a.	60.7	61.1	61.1	59.8
Importable	n.a.	13.7	12.9	12.3	14.0
Nontraded goods	n.a.	25.6	25.9	26.6	26.2
Food	n.a.	65.7	66.2	63.3	65.5
Tradable	n.a.	41.7	42.0	38.2	40.7
Exportable	n.a.	28.7	29.8	26.5	27.4
Importable	n.a.	13.0	12.2	11.7	13.3
Nontraded	n.a.	24.0	24.1	25.1	24.8
Nonfood	n.a.	34.3	33.8	36.7	34.5
Tradable	n.a.	32.6	32.0	35.2	33.2
Exportable	n.a.	32.0	31.3	34.6	32.4
Importable	n.a.	0.7	0.7	0.6	0.7
Nontraded	n.a.	1.7	1.8	1.5	1.4

Sources: Derived from Colombia, Departamento Administrativo Nacional de Estadística (DANE), *Cuentas Nacionales de Colombia 1970-1983* (Bogotá: DANE, 1984); and unpublished data from DANE, Division de Cuentas Nacionales.

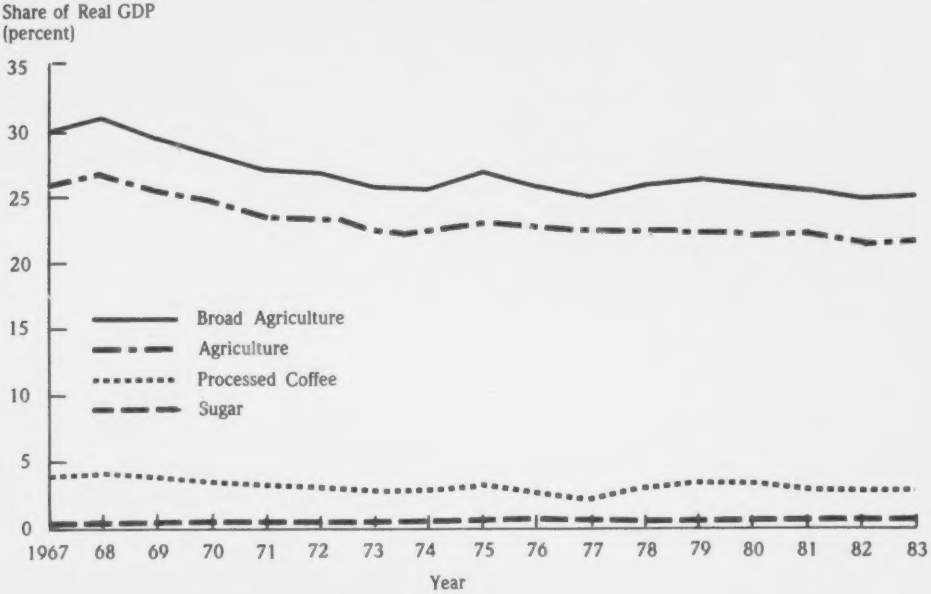
Notes: The numbers in parentheses are the sector numbers assigned in the national accounts. n.a. means not available. Pergamino is unwashed coffee.

ity exports and exports of goods and services during the period 1970-83 was 61 and 51 percent, respectively.

Coffee was the principal export product, contributing an average of 44 percent of total real commodity exports during the period 1970-83. Noncoffee agricultural exports, in turn, amounted to an average of 17 percent of total commodity exports, and the average share of exports of agricultural food products in total commodity exports was about 12 percent. Imports of agricultural commodities were relatively small during the period, an average of 5 percent of total imports of goods and services and close to 6 percent of commodity imports. Imports of food products were, on average, 5.3 percent of total commodity imports and around 5.7 percent of total commodity exports. Thus, the country is a net exporter of agricultural commodities in general (with and without coffee) as well as of agricultural food products (see Table 2). The small share of food imports in total imports means that the burden of the food import bill on foreign exchange earnings is small enough to discard any threat to the balance of payments arising from sudden increases in the volume of imports or in their external price.

For agricultural food products, the trade balance was positive and low during each year of the 1970-83 period, reaching an average of 2 percent of the real gross value

Figure 1—Real value added in agriculture as a share of real GDP



Source: Derived from Colombia, Departmento Administrativo Nacional de Estadistica, *Cuentas Nacionales de Colombia 1970-1983* (Bogota: DANE, 1984).

Notes: For the purposes of this report, agriculture includes unwashed *(Pergamino)* coffee, livestock, and other agricultural products, with the exception of processed coffee and sugar, which are included in "broad agriculture."

Table 2—Share of agricultural imports and exports in total imports and exports, selected years, 1970-83

Imports/Exports	1970	1974	1978	1982	1970-83 Average
			(percent)		
Share of real imports					
Agriculture/total commodities	6.17	6.88	7.35	6.69	6.52
Food/total commodities	5.68	6.41	6.79	6.01	5.94
Agriculture/goods and services	5.36	5.90	6.56	6.14	5.76
Food/goods and services	4.93	5.50	6.06	5.51	5.24
Share of real exports					
Agriculture/total commodities	67.02	59.25	62.30	64.41	61.12
Coffee/total commodities	47.34	43.54	44.39	46.50	44.10
Food/total commodities	11.08	10.09	12.29	13.27	11.10
Agriculture/goods and services	55.83	48.44	52.00	53.97	51.21
Coffee/goods and services	39.43	35.60	37.05	38.97	36.97
Food/goods and services	9.23	8.25	10.26	11.12	9.29

Sources: Derived from Colombia, Departamento Administrativo Nacional de Estadištica (DANE), *Cuentas Nacionales de Colombia 1970-1983* (Bogotá: DANE, 1984); and DANE, Division de Cuentas Nacionales, "Working Sheets: 1970-83," Bogotá, 1984.

of output. However, the trade balance is not positive for each agricultural product. For example, the trade balance in cereals and production of animals other than cattle was negative throughout the period and negative in recent years for vegetables and legumes (see Table 3).

External Trade

During the period 1967-83, total commodity imports increased at an annual rate of 7.2 percent and exports at 4.3 percent. The annual rate of growth of real agricultural imports was 5.0 percent and that of agricultural exports was 4.0 percent. However, when only the period 1975-83 is considered, the annual rate of growth of total commodity imports jumps to 9.9 percent and agricultural imports to 10.6 percent. The growth rate for agricultural imports accelerated to 12.7 percent per year in the final years, 1979-83. Total and agricultural exports, on the other hand, grew at 2.9 and 4.4 percent between 1975 and 1983 because of coffee, but noncoffee agricultural exports declined at the rate of 1.3 percent per year. Despite the relatively high rates of growth of imports, agricultural imports remained low relative to total imports (7.0 percent) and real agricultural value added (4.0 percent), thus casting serious doubts on popular beliefs about the potentially negative effects that the increase in the volume of agricultural imports had on the growth and development of agriculture and on the country's balance-of-payments position during the period.

External trade is not a high proportion of GNP. In fact, during the period 1965-74 the ratio fluctuated between 17 and 13 percent for total exports and between 21 and 12 percent for total imports. The low value of this ratio is also a strong characteristic of the noncoffee agricultural sector. Thus, between 1970 and 1983, on average, its export-gross output ratio was almost 9 percent and its import-gross output ratio was 4 percent. Therefore, strong changes in the volume of trade probably have only a small effect on the short-term economic performance of noncoffee agriculture as a whole. However, for specific products such as sugar or cotton—where the volume of trade is high relative to the volume of output (40 percent or more)—changes in export volume will have a significant effect on their performance.

External trade is a small proportion of agricultural food production. During the period 1970-83, imports of agricultural food products were, on average, 4.1 percent of real gross output; their largest value was 5.6 percent in 1971. Likewise, real exports of food products averaged 6.1 percent of gross output between 1970 and 1983.

In contrast with agriculture, the industrial sector is a net importer, with a negative trade balance equivalent to 18 percent of the sector's real gross value of output during 1970-83. Moreover, while agriculture generated more than 60 percent of commodity exports, industry only generated 33 percent. On the other hand, imports of agricultural commodities were only 6.4 percent of total commodity imports, while those of industrial goods were 91.4 percent.

In summary, agriculture is the main source of foreign currency earnings for Colombia and as such provides the necessary foreign exchange for the imports of all sectors. Because the country is a net exporter of agricultural commodities, policies that discriminate against exports or reduce the relative price of exportables have a negative effect on agriculture. This effect is negative because 75 percent of total agricultural output is tradable, of which 63 percent is in the exportable category.

Although the increase in imports of agricultural commodities is considered to be the main cause of the stagnation of agriculture in the 1970s and early 1980s, the

Table 3—Real agricultural exports and imports relative to the real gross value of output in agriculture, selected years, 1970-83

Sector	1970	1974	1978	1982	1983
			(percent)		
Exports (f.o.b.)					
Other agricultural production (02)	11.1	8.7	10.3	9.3	9.2
Animal production (03)	4.7	2.8	5.8	2.7	2.1
Processed coffee (08)	87.1	87.0	89.4	88.3	88.1
Sugar (12)	41.5	37.5	38.4	47.9	45.8
Total agriculture (01,02,03,08,12)	23.2	20.6	23.8	22.0	21.8
Noncoffee (02,03,12)	9.6	7.4	9.6	8.6	8.1
Coffee (01,08)	56.6	57.2	58.8	54.8	53.6
Food	6.0	5.2	7.2	6.8	6.2
Nonfood	54.1	51.5	55.5	52.4	51.3
Imports (c.i.f.)					
Other agricultural production (02)	6.1	7.6	7.5	11.4	11.1
Animal production (03)	1.4	0.5	0.4	0.5	0.4
Noncoffee agriculture (02,03,12)	3.6	3.9	4.8	5.5	5.3
Food	3.7	4.0	4.8	5.3	5.2
Nonfood	0.6	0.6	0.8	1.2	0.9
Real agricultural trade balance relative to real gross value of output					
Other agricultural production	5.0	1.1	2.8	-2.1	-1.9
Cereals (2.1)	-18.1	-22.3	-25.0	-27.9	-26.7
Sugarcane (2.2)	0.3	1.6	0.2	0.2	0.3
Raw tobacco (2.3)	74.9	72.4	68.6	44.4	30.1
Tubers (2.4)	-0.1	0.2	0.4	0.8	0.5
Vegetables and legumes (2.5)	-1.5	3.0	0.8	-24.4	-33.3
Fruits (2.6)	27.3	27.1	37.3	34.6	32.5
Oil products (2.7)	-1.6	-10.3	1.8	-13.0	-19.4
Fibers (2.8)	57.4	26.9	42.3	24.2	24.2
Other agricultural products (2.9)	-12.7	2.2	12.9	15.1	19.1
Animal production (03)	3.3	2.3	5.4	2.3	1.7
Cattle (3.1)	6.8	4.0	9.0	4.2	3.2
Poultry (3.2)	-0.6	-0.3	-0.3	-0.2	-0.2
Other animal products (3.4)	-14.7	-5.2	-2.7	-4.1	-3.4
Processed coffee (08)	87.1	87.0	89.4	88.3	88.1
Sugar (12)	41.5	37.5	20.3	47.9	45.8
Agriculture (01,02,03)	3.6	1.5	3.5	0.1	-0.1
Broad agriculture (01-03,08,12)	20.6	17.7	20.4	18.1	18.1
Noncoffee agriculture	5.9	3.5	4.8	3.1	2.8
Coffee agriculture	56.6	57.2	58.8	54.8	53.6

Sources: Derived from Colombia, Departamento Administrativo Nacional de Estadística (DANE), *Cuentas Nacionales de Colombia 1970-1983* (Bogotá: DANE, 1984); and DANE, Division de Cuentas Nacionales, "Working Sheets: 1970-83," Bogotá, 1984.

partial evidence here does not support this argument. The causes of stagnation seem to arise from domestic macroeconomic policies and external events rather than from import competition, as will be shown subsequently.

Main Economic Developments, 1967-83

Growth of Output and Evolution of Expenditure

Colombia maintained a relatively high rate of growth between 1965 and 1978, 5.5 percent per year, but economic activity has decelerated substantially since 1979. GDP grew only 2.1 percent annually in the period 1979-84. Agriculture, on the other hand, grew by 3.9 percent a year during 1965-78 but 1.3 percent during 1979-84. In 1967 an important effort to rationalize economic policy was undertaken, which, combined with a favorable environment in the world economy, made it possible to reach an average annual growth rate of 6.4 percent between 1967 and 1974, while agriculture grew at 3.7 percent. Growth continued at 4.7 percent a year in 1974-78, influenced primarily by the boom in prices and exports of coffee. As the result of domestic policies and world economic recession, growth has decelerated since 1979. Between that year and 1981 the growth rate of GDP averaged 3.7 percent per year, but it fell to 0.9 percent in 1982 and to 1.6 percent in 1983.[8]

Between 1967 and 1974 the rate of growth was sustained mainly by agriculture, manufacturing, and commerce, which grew at 4.3, 8.6, and 8.3 percent per year, respectively. Agriculture and manufacturing grew in response to export incentives and the expansion in world and domestic demand. Although the rate of agricultural growth remained at 4.5 percent between 1974 and 1978, mainly as the result of increased coffee production and exports, the rate of growth of manufacturing declined to 5.2 percent, while the services sector experienced the highest growth rate, 7.4 percent per year. Since 1978, the deceleration in the rate of growth has spread to all sectors, but mainly to manufacturing, which fell to 1.0 percent per year between 1978 and 1983.

Population and Employment

By 1985, Colombia had a total population of about 28.5 million. The annual rate of population growth has fallen in the last 30 years, from 3.4 percent in the 1950s to 2.5 percent between the mid-1960s and 1970s, and to an even lower 1.9 percent between 1975 and 1985. Another development is the increasing share of urban population in total population as a result of rural-urban migration. The urban population grew by about 4.1 percent per year between 1951 and 1985, compared with 2.6 percent per year for the total population, and the share of urbanites in the total population increased from 38.5 percent in 1951 to 65.4 percent in 1983.[9]

Between the mid-1950s and the early 1970s the growth in labor supply surpassed the increase in labor demand, and conditions in the labor market deteriorated. However, between 1974 and 1979, despite a substantial growth of the economically active population (3.4 percent per year), unemployment rates declined due to a phenomenal growth in employment. The urban unemployment rate in seven major cities dropped from 12.7 percent in June 1974 to 8.9 percent in September 1979. The largest share of the surge in employment between 1974 and 1979 went to the service and construction sectors—about 43 percent of the total—while manufacturing gained 22 percent and agriculture 16 percent.[10]

These changes in population affected real wages and real wage differentials between the urban and rural sectors. In the 1950s, the large rate of increase in population and discrimination against the agricultural sector caused real wages in agriculture to stagnate, while those in the industrial sector increased. As a result, in 1960 real agricultural wages were only 48 percent of blue-collar wages in manufacturing, while in 1951 they had been 70 percent. In the 1960s real wages in agriculture grew by 1.8 percent per year, the differences between agricultural and manufacturing wages widened, and by 1970 real wages in agriculture were only 44 percent of wages in manufacturing. In the 1970s agricultural wages rose as a result of improvement in the terms of trade for agriculture, the substantial increase in urban employment, and the surge in illegal cash crops (marijuana). Large gains in productivity that began with the adoption of new technologies in several products (rice, coffee, and bananas, for example) also contributed. As a result, agricultural real wages grew by 3.9 percent per year. In 1977, at the height of the coffee boom, rural wages were about 69 percent of industrial wages, but as the rate of growth of rural wages declined, rural wages also fell in relation to urban wages, reaching 55 percent of industrial wages in 1982.[11]

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[8] Data for computing rates of growth of GDP are from Colombia, Banco de la República, *Cuentas Nacionales de Colombia, 1950-1967* and *1968-1971*, and from Colombia, Departamento Administrativo Nacional de Estadística, *Cuentas Nacionales de Colombia, 1970-1984*, various issues (Bogotá: DANE: various years).

[9] See World Bank, *Colombia: Economic Development and Policy Under Changing Conditions* (Washington, D.C.: World Bank, 1984), Table II.3.

[10] Ibid., Table II.9; and Colombia, Departmento Administrativo Nacional de Estadística, *Colombia Estadística 1985* (Bogotá: DANE, 1985), Table 5.1.

Trends in Commercial and Exchange Rate Policies

Commercial Policies

In looking at commercial and exchange rate policies during the postwar era in Colombia, two periods can be identified: 1950-66, when import substitution and fixed exchange rate policies were dominant, and 1967-82, when a more open-economy approach to commercial policy was implemented. The implementation of these two policies had important effects on the rate of growth of the different sectors, on employment, and on income distribution.[12]

During the first period industrial output grew rapidly, thereby increasing the sector's share of total GDP. The main instruments used in this industrialization effort were high tariffs and strong quantitative restrictions on imports of consumption goods, whereas imports of raw materials and capital goods were subsidized through low tariffs and an overvalued peso. As a result, industrial consumption goods had high rates of effective protection, while the rates of protection for agricultural commodities and industrial intermediate and capital goods were low and even negative.

A process of rationalization of economic policies began in 1967, and a gradual and moderate import liberalization policy was applied until 1982. During the period 1967-74 some measures to liberalize imports were introduced, and improvements in the administration of trade policy occurred. The reduction of quota restrictions between 1968 and 1973 was not accompanied by a simultaneous reduction in tariffs. Thus, the general level of nominal tariffs as well as the variance remained fairly constant between 1968 and 1973. In 1974 there was a large reduction of both, from an average of 45.5 percent in 1973 to 31.9 percent in 1974. The standard deviation and coefficient of variation also fell, from 36.8 to 21.7 and from 0.81 to 0.68, respectively. The reduction of tariffs continued during the second half of the 1970s, but at a much slower pace.

An important aspect of the rationalization process was the reduction of the antiexport bias of commercial policies. The agricultural sector and exportables in the industrial sector were particularly favored by the shift in policy, but in general all sectors did well in this period. The gradual movement toward import liberalization was intensified in 1979-81 and reversed drastically after 1982. Its evolution was largely influenced by movements in the external price of coffee and by the accompanying macroeconomic policies (exchange rate, fiscal, and monetary).

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[11] This information has been taken and processed from Colombia, Departamento Administrativo Nacional de Estadística, *Anuarios Generales de Estadística* (Bogotá: DANE, various years, 1950-77); Colombia, Departamento Nacional de Planeación, Unidad de Programación Global-División de Precios y Salarios, "Mercado Laboral en Colombia: 1950-1977," vol. 2, Bogotá, January 1980 (mimeographed); and Colombia, Departamento Administrativo Nacional de Estadística, *Boletín Mensual de Estadística,* various issues.

[12] For a fuller documentation of commercial and exchange rate policies in Colombia during the period 1967-82, see Jorge García García, "The Timing and Sequencing of Trade Liberalization: The Case of Colombia 1967-1982," paper prepared for the World Bank, Trade and Adjustment Division, Country Policy Department, Washington, D.C., January 1987 (mimeographed).

The sharp rise in the price of coffee in 1975 and the accumulation of international reserves were factors favoring further liberalization, but a revaluation of the peso as the result of this boom, coupled with a protectionist attitude in some spheres of the administration, halted that process in 1976. The government that took office in 1978 started to implement a large public works program, which led to the development of a substantial fiscal deficit, financed by external credit and money creation. Since the liberalization implemented during this period was essentially for stabilization purposes, its life was shortened by the unfavorable economic environment under which it was carried out. The revaluation of the peso and the application of a restrictive credit policy to offset the monetary effects of the expansive fiscal policy reduced the country's rate of economic growth, diminished private economic activity, discouraged nontraditional exports, and encouraged imports. By 1983, all measures taken to liberalize trade had been fully reversed.

Exchange Rate Policies

Before 1967, exchange rate policy was characterized by multiple rates fixed for long periods of time in the face of large inflationary pressures, thus producing unsustainable balance-of-payments deficits, leading to sporadic and large devaluations of the peso. In 1967, exchange rate policy was modified by the adoption of a crawling-peg system and reduction and eventual elimination of multiple exchange rates.

The rate of "crawl" varied over time according to changes in domestic and external circumstances, but it was influenced mainly by domestic and external rates of inflation, changes in the exchange rate of Colombia's main trading partners vis-à-vis the U.S. dollar, behavior of the country's terms of trade, and accumulation of international reserves.[13] In 1968-73, when the exchange rates of the major world currencies and Colombia's terms of trade were stable, the rate of devaluation was essentially determined by the difference between the Colombian and U.S. rates of inflation.

In late 1974 and 1975 the crawl rate was accelerated in order to promote exports, to make up for a small decline in the real exchange rate during 1972 and 1973, and to compensate for the reduction in the rate of subsidization of minor exports, which was enacted in September 1974. In 1975 a coffee boom began, and in the following two years the rate of crawl declined. Although this reduced the monetary impact of the boom, it was not sufficient, and in May 1977 the peso was nominally revalued for the main export products plus all exports of services.[14] The crawl rate was increased in 1978, but reduced in 1979, again to diminish the monetary effect of the accumulation of reserves generated by another coffee boom and heavy foreign borrowing by the government. After 1979 the crawl rate increased, and it was accelerated in 1981 and 1982 with the avowed purpose of improving the competitiveness of exports, which had declined sharply since 1975.

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[13] Edwards, "Commodity Export Prices and The Real Exchange Rate."

[14] To nominally revalue the currency, a paper called a certificate of exchange was issued for each dollar surrendered to the Central Bank, with an initial maturity of 30 days and a discount of 10 percent if the exporter received pesos in exchange for dollars. Otherwise, the exporter would receive a certificate, which was freely negotiable on the stock exchange.

As a result of these influences, the real exchange rate increased between 1967 and 1971. It remained fairly stable until 1975, fell sharply in 1977 and 1978, and continued falling, although at a moderate rate, after 1980.

The evolution of the real effective exchange rate for minor exports, the relative price of exports and imports since 1967, and the profitability of exporting (the ratio of implicit prices received for sales in the domestic market versus sales in foreign markets) are presented in Table 4. From these figures it is clear that the real exchange rate and the profitability of exporting increased considerably from 1967 to 1974, but fell sharply afterward. Thus, the export promotion measures implemented after 1975 were not enough to compensate for the decline in the real exchange rate induced by the increase in the price and volume of coffee exports and the deleterious effect of larger government expenditure and deficit.

Balance of Payments and International Reserves

Colombia's external position improved from 1968 to 1975 because the deficit in the current account was more than compensated for by a moderate capital inflow that fluctuated between a net of US$200 and $400 million. As a result, international reserves went from US$152 million in 1970 to US$547 million in 1975 (see Table 5).

Between 1976 and 1980 the current account surplus generated by the gain in terms of trade was reinforced by positive capital flows, thereby leading to an accumulation of reserves that reached a peak of $5.6 billion at the end of 1981. However, the external position of Colombia began to deteriorate in 1981 and took a sharp negative turn in 1982 when the current account deficit was $2.9 billion and in 1983, when it was $2.7 billion.

These balance-of-payments movements reflect several factors that were operating through the current and capital accounts. For the current account, developments in the world economy, the behavior of export incentives and import restrictions, and the evolution of coffee exports seem to have been the main determinants. As for the capital account, the level of domestic interest rates compared with the parity rates (foreign interest rate plus devaluation) and the foreign financing of the government deficit played the leading roles.

Monetary and Fiscal Policies

During the 1966-82 period, two subperiods with different rates of monetary expansion can be clearly distinguished: 1966-71, when the money supply (M1) grew at an annual rate of 16 percent; and 1972-82, when M1 increased at 24 percent per year (see Table 6).

One distinguishing feature of monetary growth in Colombia during this period is the increase in the monetary base, at 24.4 percent per year, compared with the increase in the money supply at 21 percent per year. This means that the money multiplier continuously contracted, falling from an average of 2.0 percent for 1966-71 to an average of 1.5 for 1972-82 (a 3.4 percent reduction per year for the period as a whole). As a result, the ability of commercial banks to intermediate resources deteriorated considerably, and the spread between borrowing and lending rates by commercial banks increased sharply.

During most of the 1967-82 period fiscal policy was fairly moderate. Between 1967 and 1978 the average annual central government deficit was less than 1 percent of GDP. Subsequently, however, expansive fiscal policy produced a large and growing deficit each year, financed with Central Bank credit and foreign borrowing (Table 7).

Table 4—Real exchange rate index, relative export and import prices, terms of trade, and profitability of exporting, 1967-83

Category	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
									(1975 = 100)								
Real exchange rate																	
Morawetz	82.3	89.7	91.4	96.5	100.1	99.8	95.5	94.5	100.0	98.2	83.4	80.7	78.4	77.7	74.5	n.a.	n.a.
Ruiz																	
Total exports	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	100.0	94.5	86.4	87.5	84.6	85.4	78.5	73.7	76.2
Effective minor exports	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	100.0	96.9	90.3	92.9	90.1	93.9	93.5	89.9	93.6
Relative price of exports[a]																	
Total	72.5	75.6	73.7	87.1	78.5	84.8	98.0	104.1	100.0	119.8	130.9	104.5	91.1	97.8	78.3	73.5	72.2
Total without coffee	67.8	65.0	65.2	72.4	71.3	75.2	85.5	104.0	100.0	95.3	89.0	79.2	80.5	90.4	81.4	71.9	71.7
Coffee	78.2	87.8	86.0	109.6	89.9	102.7	123.3	104.2	100.0	169.6	245.0	147.5	105.7	108.4	73.3	76.1	72.9
Noncoffee agriculture (02,03,12)	68.5	62.6	67.1	71.2	72.8	85.7	96.3	114.1	100.0	86.6	86.6	66.0	66.1	79.6	69.7	55.0	58.0
Manufacturing (09-11,13-25)	46.9	52.5	50.7	55.5	56.5	64.9	79.1	103.9	100.0	99.1	89.2	82.7	84.0	84.8	81.9	77.3	73.8
Relative price of imports[b]																	
Total imports	81.3	88.0	84.3	82.0	78.6	78.9	83.1	98.2	100.0	95.0	86.7	76.1	76.0	78.6	71.5	65.5	63.8
Broad agriculture (01-03,08,12)	64.4	77.5	71.7	62.0	62.1	63.4	90.5	117.4	100.0	84.1	81.4	46.4	63.0	70.7	60.3	52.7	52.9
Manufacturing (09-11,13-25)	81.5	88.2	84.1	82.5	78.8	78.5	81.5	97.1	100.0	94.9	85.3	77.0	74.6	77.4	70.7	65.1	63.0
Terms of trade	90.7	91.3	94.5	106.1	100.0	107.6	117.9	106.0	100.0	126.1	150.9	137.2	119.9	124.5	109.5	112.5	113.9
Profitability of exporting																	
Agriculture (02,03)	84.8	79.0	78.7	85.0	90.6	99.2	101.5	102.8	100.0	89.4	81.0	78.9	90.8	92.4	93.9	95.6	99.6
Manufacturing (09-11,13-25)	47.4	52.6	51.1	58.5	60.3	68.2	80.1	101.8	100.0	100.8	92.7	90.1	93.0	91.9	91.7	86.5	83.0
Total (01-35)	73.1	74.6	72.6	88.7	80.7	86.1	97.5	103.1	100.0	119.1	131.7	109.8	96.9	103.4	85.8	80.9	79.7

Sources: Real exchange rates are derived from David Morawetz, *Why the Emperor's New Clothes Are Not Made in Colombia*, World Bank Staff Working Paper No. 368 (Washington, D.C.: World Bank, 1980); and Alvaro Ruiz, "La Competitividad de las Exportaciones Menores en el Periodo 1975-1983 y el Deficit en la Balanza de Pagos Registrado entre 1980-1983," *Revista de Planeacion y Desarrollo* 16 (April-September 1984): 2-3. Terms of trade are derived from implicit prices of exports and imports from national accounts in Colombia, Banco de la República, *Cuentas Nacionales de Colombia 1967-1969* (Bogotá: Banco de la República, 1970); and Colombia, Departamento Administrativo Nacional de Estadística (DANE), *Cuentas Nacionales de Colombia 1970-1983* (Bogotá: DANE, 1984). Relative prices and profitability of exporting for 1970-84 are derived from DANE, *Cuentas Nacionales de Colombia* and for 1967-69 and 1985 from unpublished data provided by DANE.

[a] Implicit price of exports/implicit price of nontraded goods.

[b] Implicit price of imports/implicit price of nontraded goods.

Table 5—Summary balance of payments, 1968-83

Year	Current Account Trade Account	Services Account	Transfers	Total	Capital Account	Change in Reserves	Level of Reserves
				(US $ million)			
1968	-10.0	-185.0	31.0	-164.0	233.0	69.0	35.0
1969	24.0	-237.0	38.0	-175.0	230.0	55.0	97.0
1970	-14.0	-315.0	36.0	-293.0	329.0	36.0	152.0
1971	-148.4	-340.0	34.1	-454.3	437.2	-17.1	170.4
1972	130.3	-355.1	34.8	-190.0	370.2	180.2	345.2
1973	280.2	-369.6	34.6	-54.8	225.3	170.5	515.9
1974	-15.6	-386.1	51.7	-350.0	258.6	-91.4	429.5
1975	292.6	-445.6	43.7	-109.3	204.0	94.7	547.3
1976	579.0	-430.4	58.1	206.7	431.7	638.4	1,165.9
1977	734.4	-352.6	58.4	440.2	145.9	586.1	1,831.1
1978	642.3	-393.1	72.6	321.8	209.0	530.8	2,479.9
1979	510.3	-120.1	100.8	491.0	1,007.7	1,498.7	4,106.1
1980	-238.2	-85.9	165.3	-158.8	1,615.2	1,465.4	5,415.7
1981	-1,543.5	-594.3	242.9	-1,894.9	2,581.2	686.3	5,630.3
1982	-2,189.2	-872.2	166.7	-2,894.7	2,375.8	-2,142.8	4,890.8
1983	-1,755.3	-1,155.6	173.2	-2,737.7	1,113.9	-1,812.0	3,078.8

Sources: International Monetary Fund, *Supplement on Balance of Payments* (Washington, D.C.: IMF, 1984); and International Monetary Fund, *International Financial Statistics: Supplement on Balance of Payments No. 7* (Washington, D.C.: IMF, 1984). Data on the level of reserves were provided by Colombia, Banco de la República, *Revista del Banco de la República*, various issues.

Notes: The data on level and change of reserves may not be compatible because they are drawn from different sources.

The low deficits of the early 1970s turned into a surplus in 1976-78, partly because of a rise in taxes but also because of a contraction in public expenditures as part of stabilization efforts. High deficits then began in 1979. Public revenues fell because of widespread tax evasion induced by the high tax rates enacted in 1974 and because access to inflationary financing was very easy.[15] When viewed from the consolidated public sector side, between 1977 and 1983 government expenditure increased from 28 to 40 percent of GDP, while revenues only increased from 27 to 31 percent of GDP (see Table 8). As a result, the consolidated public sector deficit increased from 1.2 to 8.6 percent of GDP during that period.

These movements in fiscal policy had their counterpart in money creation and the government's contribution to it. Between 1967 and 1975 the proportion of the deficit financed by money creation was equivalent to 1.0 percent of GDP. It turned negative in 1976-78, and increased sharply in the period 1979-84, reaching an average of 2.2 percent of GDP (see Table 7).

Interest Rates, Devaluation, and Inflation

During the period 1967-83 interest rates experienced a continuous upward movement caused by several factors: the acceleration in domestic inflation, the increase in reserve requirements and forced investments imposed on the commercial banking system, and restrictions on domestic credit to the private sector to limit the effects of

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[15] The easy access to inflationary finance was provided by the use of a facility at the Central Bank called the Special Exchange Account. Its sources of revenue were: taxes on coffee exports and profit remittances, interest earned on international reserves, and accounting profits in the purchase and sale of international reserves.

Table 6—Money supply, money base, and money multiplier, 1966-82

Year	Money Supply	Monetary Base	Money Supply/ Monetary Base	Money Supply/ GDP
	(P million)		(percent)	
1966	10,130	4,471	2.27	13.76
1967	11,892	5,514	2.16	14.31
1968	14,217	7,406	1.92	14.74
1969	16,584	8,813	1.88	14.95
1970	19,700	10,957	1.81	14.84
1971	22,324	12,201	1.83	14.32
1972	26,088	14,514	1.80	13.76
1973	32,961	19,147	1.72	13.56
1974	40,819	23,269	1.75	12.66
1975	50,040	28,619	1.75	12.35
1976	64,804	40,730	1.59	12.17
1977	88,488	60,742	1.46	12.36
1978	113,846	81,977	1.39	12.52
1979	141,518	105,931	1.34	11.90
1980	176,488	137,033	1.29	11.18
1981	221,370	167,509	1.32	8.96
1982	271,794	198,725	1.37	9.17

Source: World Bank, *Colombia Economic Development and Policy Under Changing Conditions* (Washington, D.C.: World Bank, 1984), p. 226, Table 6.1; and Banco de la República, computer printout.

Table 7—Central government operations as a share of GDP, 1966-82

Year	Tax Revenue	Revenue from Money Creation	Total Expenditure	Deficit[a]	Government Share/GDP[a]
			(percent)		
1966	8.80	. . .	9.80	−0.28	1.10
1967	9.20	. . .	11.40	−0.59	0.40
1968	8.50	. . .	9.30	−0.84	1.20
1969	9.28	−0.27	9.99	−0.72	0.80
1970	9.35	−0.12	10.31	−0.96	1.30
1971	8.67	−0.18	10.42	−1.76	1.60
1972	8.37	0.00	9.52	−1.15	0.47
1973	7.81	0.33	9.00	−1.19	1.07
1974	8.72	0.29	9.71	−0.99	1.39
1975	8.97	0.20	8.33	0.65	−0.72
1976	8.57	0.29	8.04	0.52	−0.60
1977	8.92	0.33	8.60	0.32	−0.52
1978	8.36	1.28	9.15	−0.79	0.20
1979	8.36	1.25	10.34	−1.97	2.20
1980	7.91	2.43	10.84	−2.94	3.20
1981	7.55	2.71	11.66	−4.11	n.a.
1982	7.10	1.76	11.35	−4.25	n.a.

Sources: Central government operations for 1967-68 are taken from Colombia, Dirección General de Presupuesto, *Boletin 64,* December 1973, pp. 119-123; and for 1970-84, from direct information from Banco de la República, Departamento de Investigaciónes Económicos. For the government contribution to the growth of the monetary base, see Robert J. Barro, "El Dinero y la Base Monetaria en Colombia: 1967-1972," *Revista de Planeacion y Desarrollo* (April-June 1973): Table 2; and for 1973-81, Colombia, Departamento Nacional de Planeacion "La Situation Fiscal de Colombia: 1970-1981," Bogotá, 1982 (mimeographed).

[a] The government share in 1967-72 corresponds to the adjusted central government deficit defined in Barro, "Dinero y la Base Monetaria."

Table 8—Consolidated public sector revenues and expenditures, nominal GDP, and revenues and expenditures as a share of GDP, 1966-82

Year	Expenditures	Revenues	Deficit	Nominal GDP	Expenditures/ GDP	Revenues/ GDP	Deficit
		(P million)				(percent)	
1966	20,924	17,920	3,004	83,083	25.2	21.6	3.6
1967	26,812	21,869	4,943	96,422	27.8	22.7	5.1
1968	34,565	25,968	8,597	110,953	31.2	23.4	7.7
1969	40,741	31,491	9,250	132,768	30.7	23.7	7.0
1970	49,287	37,650	11,637	155,886	31.6	24.2	7.5
1971	56,839	44,401	12,438	189,614	30.0	23.4	6.6
1972	61,325	78,590	−17,265	243,160	25.2	32.3	−7.1
1973	81,144	77,944	3,200	322,384	25.2	24.2	1.0
1974	105,351	109,345	−3,994	405,108	26.0	27.0	−1.0
1975	150,448	139,917	10,531	532,270	28.3	26.3	2.0
1976	197,433	178,110	19,323	716,029	27.6	24.9	2.7
1977	256,291	245,378	10,913	909,487	28.2	27.0	1.2
1978	353,545	305,135	48,410	1,188,817	29.7	25.7	4.1
1979	530,145	437,819	92,326	1,579,130	33.6	27.7	5.8
1980	697,756	562,640	135,116	1,982,773	35.2	28.4	6.8
1981	931,794	708,206	223,588	2,497,298	37.3	28.4	9.0
1982	1,213,132	953,132	260,000	3,036,661	39.9	31.4	8.6

Sources: Consolidated public sector revenues and expenditures for 1967-72 are taken from Colombia, Departamento Nacional de Planeación, *Misión Bird-Wiesner, Finanzas Intergubernamentales en Colombia* (Bogotá: Printer Colombiana, 1981), Table II-1; and for 1973-82, from Colombia, Dapartamento Nacional de Planeación, "Consolidación Financiera del Sector Publico Colombiano," Bogotá, 1984 (mimeographed). Nominal GDP is taken from Colombia, Banco de la República, *Cuentas Nacionales de Colombia* (Bogotá: Banco de la República, various years).

the financing of the government deficit via monetary expansion. (This is a classical example of "crowding out".) In addition, rising interest rates on international capital markets were also an important element in pushing domestic interest rates upward.

The 1967-77 period can be characterized as one of low interest rates (with the exception of 1973-74), while the period 1978-83 can clearly be classified as high (see Table 9). It is not mere coincidence that the trend growth rate of the economy dropped sharply in the latter period. As a result of the severe restrictions on capital inflows since 1976 and the reduction in the rate of devaluation, the differential between the domestic and parity interest rates increased strongly between 1975 and 1979. After 1979, the increase in the rate of devaluation, the stabilization of domestic interest rates, and the increase in interest rates in the international capital markets combined to reduce the differential. In 1983 a complete reversal of the situation that existed between 1975 and 1979 took place, and the parity rate turned higher than the domestic one.

Relative Prices

This section examines the behavior of agricultural prices relative to prices in the nonagricultural sector. Since 1970, substantial changes in relative prices have taken place, induced by movements in the country's international terms of trade and domestic economic policies. A complete set of relative prices for agriculture as a whole and for various categories of agricultural products during the period 1970-83 is presented in Table 10.

For this discussion, two classifications of agricultural production have been adopted: the first distinguishes between coffee and noncoffee, and between food, nonfood, and

Table 9—Domestic interest rate, devaluation, interest rate differential, and parity rate, 1967-83

Year	Interest Rate		Devaluation	Interest Differential[a]	Parity Rate[b]	Euro-dollar
	Nominal	Real				
			(percent)			
1967	13.6	4.8	16.9	−7.9	23.3	5.5
1968	13.6	3.8	7.1	−0.3	13.9	6.4
1969	12.9	4.2	5.5	−2.5	15.8	9.8
1970	13.3	2.8	6.9	−2.4	16.0	8.5
1971	16.4	5.3	9.5	−0.2	16.7	6.6
1972	15.6	2.3	9.0	0.5	14.9	5.5
1973	15.8	−3.7	8.8	−2.6	18.9	9.2
1974	30.7	4.2	15.5	1.9	28.2	11.0
1975	27.4	3.7	15.1	3.5	23.1	7.0
1976	21.2	−3.4	10.2	4.2	16.3	5.6
1977	19.8	−7.2	4.5	8.2	10.8	6.0
1978	20.2	2.7	8.0	2.4	17.4	8.7
1979	30.6	5.2	7.3	8.7	20.1	12.0
1980	34.4	5.3	15.7	1.5	32.3	14.4
1981	37.3	11.8	16.0	1.6	35.2	16.5
1982	38.0	10.8	19.0	2.5	34.6	13.1
1983	33.7	14.2	26.3	−3.4	38.4	9.6

Sources: For the Eurodollar rate, International Monetary Fund, *International Financial Statistics Yearbook 1984* (Washington, D.C.: IMF, 1984), United Kingdom page, line 60d; for interest rates for 1968-73, Gabriel Montes and Ricardo Candelo, "El Enfoque Monetario de la Balanza de Pagos: El Caso de Colombia, 1968-1980," *Revista de Planeación y Desarrollo* (May-August 1982); and for interest rates for 1974-83, Patricia Correa, "Determinantes de la Cuenta de Servicios de la Balanza Cambiaria," *Ensayos sobre Política Económica* (December 1984).

Note: For 1967, the interest rate was assumed to be equal to the 1968 rate.

[a] Interest differential = (1 + nominal rate)/(1 + parity rate) − 1.

[b] Parity rate = (1 + Eurodollar) (1 + devaluation) − 1.

nonfood without coffee. The second classifies agriculture as traded and nontraded, and makes a distinction in the traded sector between importables and exportables, the latter comprising the coffee and noncoffee sectors.

The data in Table 10 show a clear pattern. For agriculture as a whole, relative prices increased during 1970-73 and 1975-77, fell during 1973-75, and decreased continuously after 1977. This movement in relative prices is linked to movements in the country's external terms of trade, which are dominated by movements in the price of coffee.

Coffee and Noncoffee. To clarify the movement of relative prices, a distinction is made between coffee and noncoffee agriculture. Then it can be seen that the price of noncoffee agriculture rose between 1970 and 1974 and declined afterwards, with the exception of 1977 when it increased by 6 percent due to a substantial shortfall in trend output. Thus, the underlying forces that reduced the relative price of noncoffee agriculture were present from 1975.

Coffee prices do not show a well-defined trend between 1970 and 1975. Between 1975 and 1977 the price more than doubled, then declined consistently, by 60 percent, until 1983.

The decline in noncoffee agriculture prices began in 1975, but a sharp fall of 10 percent took place in 1978. The largest decline—16 percent—occurred in crops, and the smallest one—3 percent—in animal production. In 1979 there was a further 6 percent reduction in the price of noncoffee agriculture, and for the rest of the period,

Table 10—Relative price index for agricultural output, 1970-83

Item	1970	1971	1972	1973	1974	1976	1977	1978	1979	1980	1981	1982	1983
						(1975 = 100)							
Total agricultural output (01,02,03,08,12)	98.2	94.1	99.1	109.5	106.4	111.8	127.4	109.8	95.7	2.0	82.8	82.7	81.7
Noncoffee	92.3	93.4	96.8	105.4	107.5	98.3	103.9	93.8	88.0	85.2	83.0	82.9	82.5
Crops production (02)	97.3	97.0	96.7	102.4	103.2	97.0	99.1	83.3	79.4	77.8	76.7	76.1	74.5
Animal production (03)	88.0	91.2	97.9	110.2	111.3	99.6	107.5	104.3	96.4	88.3	86.4	88.0	86.7
Sugar (12)	82.8	81.6	87.2	88.3	113.9	98.2	120.9	104.5	95.3	120.2	108.9	95.3	110.2
Coffee	112.6	95.9	105.3	120.6	103.3	151.0	202.3	149.5	112.2	106.8	82.5	82.0	79.8
Pergamino coffee (01)	111.4	95.4	102.4	112.8	100.5	135.6	175.3	146.8	116.3	100.7	89.7	84.4	83.5
Processed coffee (08)	113.3	96.2	106.8	124.6	104.8	159.2	222.3	150.8	110.2	109.9	78.0	80.5	77.4
Food	91.9	93.0	96.2	105.2	106.8	97.3	103.1	93.7	87.5	84.4	82.4	82.6	82.4
Nonfood	109.4	96.4	104.8	118.0	105.6	142.4	181.3	140.5	109.7	104.8	83.7	82.7	80.4
Nonfood noncoffee	95.9	98.2	102.7	107.1	114.9	108.6	111.5	94.7	94.6	93.5	89.7	87.8	84.1
Tradables	96.5	89.8	96.6	108.6	106.7	118.2	139.3	118.6	100.9	96.9	85.2	84.7	84.3
Exportables	96.3	88.6	96.9	109.3	107.0	122.4	148.7	125.1	103.7	99.2	85.2	84.6	84.2
Coffee (01,08)	112.6	95.9	105.3	120.6	103.3	151.0	202.3	149.5	112.2	106.8	82.5	82.0	79.8
Noncoffee	81.5	82.4	90.1	100.1	109.9	100.8	110.5	102.3	94.6	91.4	87.8	87.1	88.7
Importables	97.4	94.7	95.3	105.7	105.2	99.7	100.2	88.0	86.9	85.1	85.2	85.0	84.4
Nontraded	102.9	106.9	106.7	112.0	105.5	94.4	98.0	86.9	81.3	77.7	76.0	76.9	74.5
Relative prices within the agricultural sector													
Tradables/nontraded	93.8	84.0	90.6	97.0	101.1	125.3	142.1	136.5	124.1	124.8	112.1	110.1	113.1
Noncoffee tradables/nontraded	83.8	80.5	85.9	90.8	102.9	106.5	109.7	113.0	113.5	115.4	114.5	112.3	117.2
Coffee/nontraded	109.4	89.8	98.7	107.7	97.9	160.0	206.4	171.9	138.0	137.6	108.6	106.5	107.1
Noncoffee exportables/nontraded	79.2	77.1	84.5	89.4	104.2	106.8	112.7	117.7	116.3	117.7	115.4	113.2	119.0
Importable/nontraded	94.6	88.6	89.3	94.4	99.7	105.7	102.2	101.3	106.9	109.6	112.0	110.5	113.3
Coffee/noncoffee agriculture	122.0	102.7	108.8	114.4	96.1	153.7	194.7	159.3	127.5	125.5	99.5	98.8	96.7
Exportable/importable	98.9	93.6	101.7	103.4	101.8	122.8	148.4	142.1	119.3	116.6	100.1	99.5	99.7
Noncoffee exportable/importable	83.7	87.0	94.5	94.7	104.5	101.1	110.4	116.2	108.8	107.4	103.0	102.4	105.0
Food/nonfood	84.0	96.5	91.8	89.1	101.1	68.3	56.9	66.7	79.7	80.5	98.5	99.9	102.6
Food/noncoffee nonfood	95.9	94.7	93.6	98.3	92.9	89.6	92.5	98.9	92.5	90.3	91.8	94.1	98.0
Crops (02)/Animal sector (03)	110.5	106.3	98.7	92.9	92.7	97.5	92.2	79.9	82.3	88.1	88.8	86.5	85.9
Sugar (12)/animal sector (03)	94.0	89.4	89.0	80.1	102.4	98.6	112.4	100.3	98.9	136.1	126.1	108.3	127.2
Sugar (12)/crops (02)	85.0	84.1	90.2	86.2	110.4	101.2	121.9	125.5	120.1	154.5	142.0	125.2	148.0

Source: Derived from Colombia, Departamento Administrativo Nacional de Estadística (DANE), *Division de Cuentas Nacionales,* "Working Sheets: 1970-83," Bogotá, 1984.

Notes: This table shows the implicit price of gross value of agricultural output relative to implicit price of gross value of nonagricultural production. The numbers in parentheses are the national account codes for the various components of the agricultural sector.

1980-83, the decline reached 6 percent. As for coffee, after the increase in prices in 1975-77, it fell 26 percent in 1978, a decline that continued, reaching 29 percent between 1979 and 1983.

Food and Nonfood. For the food and nonfood sectors, the pattern of relative price movements is similar to that for coffee and noncoffee agriculture. Excluding the effects of changes in coffee prices in nonfood agriculture, its relative price increased between 1970 and 1974, declined in 1975, rose again in 1976, and fell steadily afterward. Similarly, the price of food increased 16 percent between 1970 and 1974 and, excluding 1977, fell 23 percent between 1974 and 1983.

The fall in the relative price of noncoffee agriculture was unevenly distributed among sectors. Sugar prices do not present a defined trend during the period, and they varied widely as a result of large variations in the international price of sugar. The price of animal production fell 20 percent between 1977 and 1983. The sharpest decline in prices between 1974 and 1983—28 percent—took place in the crops sector. The size of the decline and its permanence most likely exerted a strong negative influence on production in this sector. On the other hand, the decline in the price of crops relative to the price of animal production (most of it livestock) probably drove the price of land downward relative to what it would have been otherwise and may have discouraged the adoption of higher-yield technologies in the livestock sector.

Tradables and Nontradables. Movements in the prices of tradable products are dominated by movements in the price of coffee. Excluding coffee, the relative price of noncoffee tradables rose between 1970 and 1974 and declined afterwards. The price of noncoffee exportables increased 35 percent between 1970 and 1974, fell in 1975, increased in 1976 and 1977, and fell 20 percent between 1977 and 1983. Prices for the importable sector increased 8 percent between 1970 and 1974 and fell 20 percent between 1974 and 1983. Between 1973 and 1983 the largest decline in prices (33 percent) took place in the nontraded sector of agriculture. A tentative explanation for this result is that most output in the nontradable sector of agriculture is composed of food items like potatoes, cassava, and plantain for which the income elasticity of demand is rather low (see Appendix 1). For these products the growth in demand was smaller than the increase in production, especially for those where substantial improvements in productivity occurred (for example, potatoes).

The increase in the prices of noncoffee agriculture between 1970 and 1974 can be explained by more consistent macroeconomic policy management plus some trade liberalization, which led to an increase in the real exchange rate of noncoffee agriculture. The price drop since 1974 can be explained by increases in the terms of trade and in the volume of coffee exports in the second half of the 1970s, plus a large surge in government expenditure in the late 1970s and early 1980s. The monetization arising from the increase in international reserves was partially offset by a central government surplus in 1976-78, which avoided a larger deterioration of the real exchange rate. The large fiscal deficit that began to develop in 1979 became an important factor in maintaining the downward pressure on the relative price of traded commodities after that year.

4

A MODEL AND EMPIRICAL EVIDENCE

Conceptual Framework

The Colombian economy can be considered a small semiopen economy which is a pricetaker in goods and capital markets. Trade in commodities and the mobility of capital are hampered by restrictions and administrative controls. Therefore, in modeling such an economy, domestic prices are affected by international prices and foreign interest rates, as well as by domestic policies.[16]

This chapter examines the effects of an increase in prices and exports of coffee, as well as the effects of growing government expenditures and fiscal deficits, on the competitive position and production of noncoffee tradables, with particular emphasis on agriculture. In order to illustrate the effects of changes in terms of trade and government expenditure on the real exchange rate and the relationship between the prices of tradable and nontradable commodities, a small open economy with three commodities is analyzed. They are nontraded commodities (N), coffee (C), and noncoffee tradables (T).

In this model there are two relative prices: $P_N = P_n/P_t$ and $P_C = P_c/P_t$, where P_n is the price of nontraded commodities, P_c is the price of coffee, and P_t is the price of noncoffee tradables.

It is assumed that the supply of each commodity depends positively on its own relative price, on the factors of production used, and on the available technology (t). It is also assumed that each sector j(j = N, T, and C) uses capital (K), land (LA), and labor (L). That is,

$$N_s = N_s(P_N, P_C, L_N, K_N, LA_N, t), \tag{1}$$

where

$$\partial N_s/\partial P_N > 0, \partial N_s/\partial P_C < 0, \partial N_s/\partial L_N, \partial N_s/\partial K_N, \partial N_s \partial LA_N, \partial N_s/\partial t > 0;$$

$$T_s = T_s(P_N, P_C, L_T, K_T, LA_T, t), \tag{2}$$

where

$$\partial T_s \partial P_N < 0, \partial T_s/\partial P_C < 0, \partial T_s/\partial L_T, \partial T_s/\partial K_T, \partial T_s/\partial LA_T, \partial T_s/\partial t > 0; \text{ and}$$

$$C_s = C_s(P_N, P_C, L_C, K_C, LA_C, t), \tag{3}$$

where

$$\partial C_s/\partial P_N < 0, \partial C_s/\partial P_C > 0, \partial C_s/\partial L_C, \partial C_s/\partial K_C, \partial C_s/\partial LA_C, \partial C_s/\partial t > 0.$$

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[16] The model presented in this section is based on Rudiger Dornbusch, *Open Economy Macroeconomics* (New York: Basic Books, 1980), chapters 6, 7, 10, and 11; Carlos A. Rodriguez, "Gasto Público, Deficit y Tipo Real de Cambio: Un Análisis de sus Interrelaciones de Largo Plazo," *Cuadernos de Economía* 57 (August 1982): 203-216; Jacob Frenkel and Michael Mussa, "Asset Markets, The Exchange Rate and the Balance of Payments: The Reformulation of Doctrine," *Handbook of International Economics,* ed. R. Caves and R. Jones (Amsterdam: North Holland, 1985); and W. Max Corden and J. Peter Neary, "Booming Sector and Deindustrialization in a Small Open Economy," *Economic Journal* 92 (December 1982): 825-848.

In equation (1) the output of nontraded goods increases with an increase in its relative price, while in equation (2) the output of noncoffee tradables declines as the relative price of nontradables rises. In equation (3) the output of coffee increases as the relative price of coffee rises. An increase in the price of coffee reduces the *combined* output of nontraded goods and noncoffee tradables, but the effect on the output of each of these commodities is not clear because it depends on the relative factor intensities of the tradable and nontraded sectors.[17] For purposes of this exposition, it is assumed that an increase in the price of coffee tends to reduce the output of both tradable and nontraded commodities.

Total aggregate supply (total income) measured in terms of noncoffee tradables is

$$Y = N_s P_N + T_s + C_s P_C. \tag{4}$$

To simplify the exposition, on the demand side it is assumed that all coffee production is exported, and that changes in the price of coffee do not affect the demand for tradables and nontraded goods, as far as the substitution effect goes.[18] The price of coffee affects the demand for tradable and nontraded goods via changes in income and expenditure, which are positively related to the price of coffee. In other words, the demand for tradables and nontraded goods can be expressed as a function of one relative price, that of noncoffee tradables, and of aggregate expenditure. It is assumed that the demand for nontraded goods increases with decreases in price and increases in expenditure. On the other hand, the demand for noncoffee tradables increases when the price of nontraded goods and expenditures rise. The demand for nontraded goods and noncoffee tradables can then be expressed as follows:

$$N_d = N_d(P_N, E), \tag{5}$$

where

$$(\partial N_d/\partial P_N) < 0,\ (\partial N_d/\partial E) > 0;\ \text{and}$$

$$T_d = T_d(P_N, E), \tag{6}$$

where

$$(\partial T_d/\partial P_N) > 0,\ (\partial N_d/\partial E) > 0,$$

where E stands for total expenditure.

Equilibrium in the market for nontraded goods is established when demand equals supply. That is,

$$N_s = N_d. \tag{7}$$

Equilibrium in the traded goods market occurs when there is equilibrium in the nontraded goods sector and the current account equals zero (income equals expenditure). For equilibrium in the traded goods market to exist, it is necessary that

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[17] For an exposition of the possible effect on the output of nonbooming sectors of an increase in the price of the main export sector, see Corden and Neary, "Booming Sector and Deindustrialization."

[18] This assumption is reasonable because about 85 percent of coffee output is exported and the own-price elasticity of demand for coffee is very low.

$$T_s + P_C C = T_d. \quad (8)$$

Effects of Changes in Coffee Price

From the above set of equations, what happens to the real exchange rate when the price of coffee goes up can be examined. With the level of resources for the economy held constant, the market for nontraded goods is looked at first. On the supply side, an increase in the price of coffee will draw resources out of the nontraded goods sector, thereby creating an excess demand for nontraded commodities. On the demand side, an increase in the price of coffee increases the demand for nontraded goods on account of its effect on real income and hence, on expenditure. As a result, an increase in the price of coffee will tend to create an excess demand in the nontraded goods market, thereby increasing their price.

In the tradable goods market, an increase in the price of coffee reduces the supply of noncoffee tradables as resources are taken away by coffee. This resource movement effect creates an excess demand for tradables (combined output of coffee *and* noncoffee) and tends to reduce the price of nontraded goods. However, this is only one of the effects of the increase in the price of coffee. On the demand side, an increase in the price of coffee increases income and hence expenditure, thus driving up the demand for noncoffee tradables. Therefore, the net effect of the increase in the price of coffee is to increase the excess demand for noncoffee tradables, thereby pushing the price of nontraded goods downward.

Moving now to the effects of coffee on the tradable market, there are two. First, the increase in the price of coffee increases the total supply of tradables by an amount equal to the increase in the price of coffee. Second, the increase in the price of coffee draws resources toward coffee production but takes them away from the noncoffee tradable and nontraded sectors. Presumably, the new allocation of resources is better than the old one, which means that the overall effect of the increase in the price of coffee is to increase the supply of tradables. Thus, the two effects—price and quantity—tend to increase the supply of tradables. The expenditure effect on coffee does not take place because it is assumed that all coffee production is exported.

To summarize, in the case of tradables, an increase in the price of coffee increases the excess demand for noncoffee tradables and the excess supply of coffee.[19] The net effect is not defined. However, there is a strong presumption that the increase in the price of coffee tends to create an excess supply of tradables, thus driving the price of noncoffee tradables downward. This is presumed because coffee draws resources out of both the noncoffee tradable and the nontraded sectors; therefore the increase in coffee output is larger than the decline in the output of noncoffee tradables. On the other hand, the increase in demand for noncoffee tradables due to the expenditure effect is smaller than the increase in the value of coffee exports because part of the increase in income (equal to the increase in the value of coffee exports) is spent on nontradables. Therefore, an increase in the price of coffee tends to increase the price of nontradables relative to the price of noncoffee tradables.

Government Expenditure, Interest Rates, and the Real Exchange Rate

Government Expenditure. In the discussion on the effects of an exogenous change in the external price of coffee, it was mentioned that an increase in the price of coffee affected total expenditure via its indirect impact on income. In this section the effects on relative prices of changes in government expenditure are explored.

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[19] In the case of coffee, excess supply and supply are the same because it is assumed that there is no domestic consumption of coffee.

To analyze the effect of changes in government expenditure on relative prices, it is assumed that total expenditure is divided between government expenditure (G) and private expenditure (E_P). E_P depends positively on disposable income (Y_d) and negatively on the real interest rate (r). That is,

$$E = E_P + G; \tag{9}$$

$$E_P = E(Y_d, r) = E(Y - I, r), \tag{10}$$

where I is government revenue from taxes;

$$\partial E_P / \partial (Y - I) > 0; \text{ and } \partial E_P / \partial r < 0. \tag{11}$$

The government, in turn, purchases nontradable (G_N) and noncoffee tradable goods (G_T).[20]

Equilibrium in the market for nontraded goods is established when demand equals supply. That is,

$$N_s = N_d + G_N, \tag{12}$$

where N_d now represents the demand of the private sector for nontraded goods.

Equilibrium in the traded goods market occurs when there is equilibrium in the nontraded goods sector and the current account equals zero (income equals expenditure). To have equilibrium in the traded goods market, it is necessary that

$$T_s + P_C C = T_d + G_T, \tag{13}$$

where T_d now represents the demand of the private sector for noncoffee tradables.

It is assumed that the government finances its expenditure entirely with taxes. That is,

$$G = G_T + G_N = I. \tag{14}$$

An increase in government expenditure increases the demand for nontraded goods if the government's propensity to purchase them is higher than the private sector's. In that case, the price of noncoffee tradables will increase. This result holds whether viewed from the nontraded or the traded goods markets. The initial statement corresponds to the analysis from the nontraded viewpoint. Viewed from the perspective of the market for tradables, the increase in the government demand for tradables is less than the reduction in the demand for tradables by the private sector induced by the increase in taxes. Thus, an excess supply of tradable goods develops, and to have equilibrium in that market, the price of nontraded commodities must increase.

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[20] To assume that the government only purchases noncoffee tradables and nontraded commodities might appear somewhat unrealistic in the Colombian case because the government is an important purchaser of coffee via the National Coffee Fund (NCF). Because coffee purchased by the NCF is exported, however, it can be interpreted that NCF only acts as an export agent of domestic producers, in which case the assumption is justified.

When government expenditure is financed with external loans and money creation, then the budget constraint of the government is given by

$$G = I + FB + B_G, \qquad (15)$$

where FB stands for net foreign borrowing and B_G is money creation that finances government expenditure.

If the government's propensity to spend on traded and nontraded commodities is independent of the method of financing, and if the government's marginal propensity to spend on nontraded goods is larger than that of the private sector, then an increase in government expenditure will increase the price of nontraded goods, no matter whether it is financed with foreign borrowing or credit from the Central Bank.

The effect of government expenditure on relative prices is smaller if the public considers that taxes have to be increased to pay the government's external debt. A similar reasoning applies if Central Bank credit to the government has to be repaid in the future. Thus, the public would discount future taxes and adjust its consumption correspondingly. In this case, the situation is the same as the one in which all government expenditure is financed with taxes, and the extent of the effects of such expenditure depends on the relative size of the government and private sector propensities to spend on nontraded commodities.

For most of the period under analysis, the Colombian public sector ran a deficit, which was financed in part with domestic savings, in part with money creation, and in part with foreign loans. Thus, the pressures on the market for nontraded goods created by increases in government expenditure did exist, thereby producing an excess demand for nontraded commodities that pushed their relative price up. Therefore, a positive effect of government expenditure on the price of nontraded goods should be expected.

Interest Rates. Interest rates are the link between savings and investment. Savings are used to finance the government deficit and investment, and the latter is part of the process of capital accumulation, which will be dealt with in the following section. Here, the impact of changes in the interest rate on the relative price of nontraded commodities is discussed.

Looking at the market for nontraded commodities, an exogenous increase in the interest rate reduces expenditure and the demand for nontraded goods, thereby creating an excess supply that drives their price downward. On the other hand, looking at the market for noncoffee tradables, a higher interest rate reduces expenditure and creates an excess supply, thus driving the price of nontraded goods up. In other words, the final effect of changes in the interest rate on the relative price of nontraded goods can be positive or negative, because it depends on the relative size of the excess supplies of nontraded and tradable goods.

However, if the nontraded goods sector is composed mainly of services, where changes in the interest rate probably have little or no effect on expenditure, and the traded goods sector is composed of commodities, where the effect of the interest rate is considerable, an increase in the interest rate will probably increase the relative price of nontraded goods. According to the classification of the various sectors presented in Appendix 1, the nontraded goods sector is composed to a large extent of services, whereas the traded goods sector is composed mainly of manufactured and agricultural products. Thus, there is a strong presumption that increases in the interest rate will lead to an increase in the relative price of nontraded goods.

Growth of Resources

Relative prices can be affected by the growth of capital and labor and by technical change. In the same way, the stock of capital, the labor force, and technical change vary with changes in relative prices. A detailed treatment of these interactions is beyond the scope of this report, but it is worth pointing out some aspects that are relevant for determining the impact on relative prices of changes in total output.[21]

The growth of resources increases the output and the demand for all commodities. The final effect of growth on relative prices depends on the relative growth of demands and supplies of coffee, nontraded, and noncoffee tradable commodities. To simplify the exposition, on the output side the discussion is carried on in terms of the effects of overall growth on the output of each sector. These changes in sectorial output are then compared to changes in the demand for each product due to economic growth.

Briefly, growth may affect relative prices in the following ways. From the viewpoint of the noncoffee tradable sector, a faster increase in demand than in supply may generate a deficit in the current account, which would have to be closed by a fall in the relative price of nontraded commodities. But, viewed from the coffee sector side, when coffee output grows faster than the output of noncoffee tradables, a potential surplus in the current account develops, and the relative price of nontraded goods will probably increase. Viewed from the nontraded goods sectors' side, the price of noncoffee tradables tends to increase if the demand for nontraded goods increases faster than its supply. The final effect on relative prices will depend on the relative size of these forces. The relative price of nontraded goods will increase when three conditions are met: first, the demand for nontraded goods increases faster than its supply; second, the output of noncoffee tradables increases faster than its demand; and third, the output of coffee increases faster than that of noncoffee tradables.

In sum, the relative price of nontraded goods depends on four variables: the growth of output, the price of coffee relative to noncoffee tradables, the real interest rate, and government expenditure. It is expected that an increase in government expenditure and the price of coffee will increase the price of nontraded goods if the former is biased toward nontraded goods and if the latter increases real income and, hence, expenditure. No strong presumption exists on the effects of economic growth and interest rate changes on the relative price of nontraded goods. However, if the nontraded goods sector is composed mainly of services, then an increase in interest rates will tend to increase its relative price.

Monetary Dynamics and Capital Inflows

To introduce monetary aspects in this model, the following demand for money function is postulated:

$$M^d/P = L(i, Y), \qquad (16)$$

where

$$(\partial L/\partial i) < 0, \text{ and } (\partial L/\partial Y) > 0,$$

where i is the nominal interest rate, and P is the general price level. Equilibrium in the money market occurs when the supply of money, M^s, equals the demand for money, M^d. That is,

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[21] An application of these interactions for Argentina can be found in Domingo Cavallo and Yair Mundlak, *Agriculture and Economic Growth in an Open Economy: The Case of Argentina,* Research Report 36 (Washington, D. C., IFPRI, 1982).

$$M^s = M^d = PL(i, Y). \qquad (17)$$

Changes in the money supply take place via changes in domestic credit and changes in international reserves.

As postulated at the beginning of this chapter, the Colombian economy can be thought of as a semiopen economy, where government regulations restrict capital mobility but where domestic interest rates, nevertheless, follow the parity rate, $i^*(1 + \hat{e})$, where i^* is the foreign interest rate and $\hat{e}$, the rate of devaluation.[22] If this is so, the level of the domestic interest rate depends on both external and internal factors. This means then that the adjustment is not instantaneous and, at least in the short run, monetary policy has an impact on the economy. In the long run the domestic interest rate adjusts to the parity rate.

It is also assumed that the government follows some rule to fix the evolution of the exchange rate, but this information is exogenous to the model. The adjustment of the domestic interest rate to changes in domestic and external factors takes place through a coefficient θ per unit of time on the external factors and $(1 - \theta)$ on the internal factors. The latter is given, in turn, by the excess demand for money. Hence, the nominal interest rate is given by

$$i = \theta[i^*(1 + \hat{e})] + (1 - \theta)(M^d/P - M^s/P). \qquad (18)$$

Replacing equation (16) in (18), gives

$$i = \theta[i^*(1 + \hat{e})] + (1 - \theta)l(i, Y, M_s/P); \qquad (19)$$

and

$$i = i\ (\theta, i^*, \hat{e}, Y, M^s/P), \qquad (20)$$

where

$$\partial i/\partial i^*,\ \partial i/\partial \hat{e},\ \partial i/\partial Y > 0,\ \partial i/\partial (M^s/P) < 0.$$

Equation (20) represents the evolution of the domestic asset market in the short run, where the interest rate will depend negatively on the real quantity of money and positively on the external rate of interest, real income, and the rate of devaluation. In the long run, the disequilibrium in the money market disappears ($M^d = M^s$), and the second term of the right-hand side of equation (18) becomes zero. Moreover, in the long run, θ tends to 1 and i tends to the parity rate $i^*(1 + \hat{e})$.

Equations (7) and (8), denoting equilibrium in the traded and nontraded goods markets, can now be combined with equation (19) to obtain a better idea of the forces at hand. Equation (8) now includes the capital flows (K) induced by the difference between the domestic and parity rates. Defining K as

$$K = f[i/i^*(1 + \hat{e})] = f(\lambda), \qquad (21)$$

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[22] See, for example, Sebastian Edwards, "Money, the Rate of Devaluation, and Interest Rate in a Semi-Open Economy: Colombia, 1968-1982," *Journal of Money, Credit and Banking* 17 (February 1985): 59-68; and Sebastian Edwards and Mohsin Khan, "Interest Rate Determination in Developing Countries: A Conceptual Framework," *IMF Staff Papers* 32 (September 1985): 377-404.

where

$$\lambda = i/i^*(1 + \hat{e}),$$

and

$$dK/d\lambda > 0.$$

Equation (8), which shows the budget constraint in the traded goods market has to be modified to

$$T_s + P_C C + K = T_d. \tag{22}$$

Equation (22) represents equilibrium in the balance of payments. Once this is obtained, the effects of terms-of-trade changes and variations in government expenditure on relative prices can be analyzed. Graphical analysis is used to examine the effect of such changes.

Graphical Analysis

The graphical analysis is based on equations (8), (20), and (22), which represent equilibrium in the nontraded goods, assets, and tradable goods markets, respectively.

For simplicity, it is assumed that the exchange rate is fixed and that the expected rate of inflation is zero ($\pi^e = 0$). Then, as a result of these assumptions, $i = r = i^*$. In Figure 2, where $r = i$ is measured in the vertical axis and P_N in the horizontal axis, there are three schedules. The curve NN represents equilibrium in the nontraded goods market. It has a negative slope because an increase in P_N creates an excess supply of nontraded commodities, which is eliminated with an increase in expenditure via a reduction in the interest rate. The curve TT has a positive slope because an increase in the interest rate reduces absorption and tends to create a balance-of-payments surplus; to eliminate the surplus, an increase in P_N is required. A capital inflow requires an increase in the relative price of nontraded goods to maintain balance-of-payments equilibrium and, therefore, moves the curve TT to the right. Finally, the curve AA represents equilibrium in the asset market and, from equation (20), it has a positive slope.

The working of the model can be illustrated by looking at the effect of an increase in the price of coffee. Starting from an initial equilibrium position in E^0, with $i = i^*$, an increase in the price of coffee increases real income, creates an excess demand for nontraded goods, and shifts the NN schedule to the right, to N′N′. The TT curve has two forces operating in opposite directions. On the one hand, the increase in real income creates an excess demand for tradables that has to be eliminated by a reduction in the price of nontraded goods; for this reason the TT curve has to shift to the left. On the other hand, a higher price of coffee increases the inflow of foreign exchange and creates an excess supply in the traded goods market. The increase in real income due to a rise in coffee prices, $dY = P_N dN_s + dT_s + P_c dC_s + C_s dP_c$, is smaller than the increase in foreign exchange earnings, $dT_s + P_c dC_s + C_s dP_c$, which means that expenditure on noncoffee tradable commodities increases by less than the rise in foreign exchange earnings. Therefore, an increase in coffee prices creates an excess supply in the market for tradable goods and shifts TT to the right, to T′T′, and pushes P_N up.[23]

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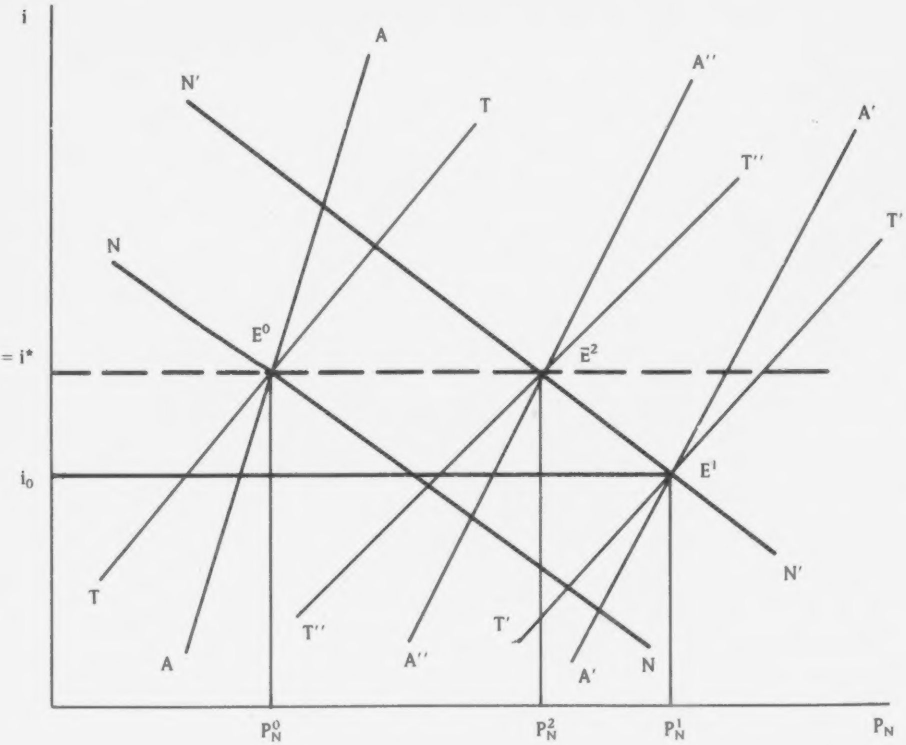
[23] The reason why real income increases by less than foreign exchange earnings is that income increases less than the expansion of coffee output because the output of nontraded and noncoffee tradable goods declines by the resource movement effect.

Figure 2—Effects of an increase in the price of coffee

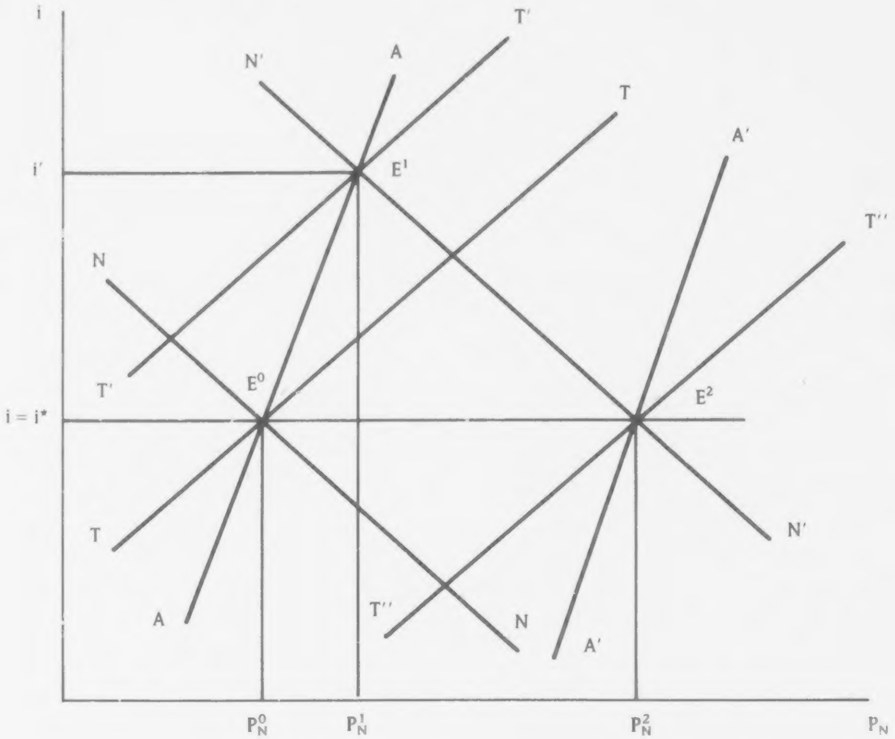


Due to the increase in the money supply induced by the trade surplus, AA shifts to the right and tends to lower interest rates. The short-run equilibrium is at E^1 with a higher $P_N(P_N^1)$, and a lower interest rate, i_0.

However, because i_0 is lower than i*, there is a capital outflow that reduces the money supply and shifts T'T' to T"T" and A'A' to A"A". The long-run equilibrium position is at E^2, with a relative price P_N^2 lower than P_N^1, and interest rate i_0. Then, in the short run P_N will "overshoot," and in the long run, equilibrium P_N will be determined by real forces (real income, the external terms of trade, and the external real rate of interest).

The effects of fiscal policy can also be looked at graphically, assuming that there is an increase in government expenditure financed with taxes (see Figure 3). The assumptions that government expenditure is biased toward domestic goods and that private-sector expenditure is biased toward traded goods are maintained. The initial equilibrium position is E^0. An increase in government expenditure shifts the NN curve to the right, to N'N', and the TT curve to the left, to T'T'. The two curves, T'T' and N'N' intersect at E^1, at a higher interest rate, i_1. A higher domestic interest rate produces a capital inflow, and the real quantity of money increases, thus reducing the rate of interest. The higher capital inflow moves the T'T' curve to the right, and the higher quantity of money does the same thing to the AA curve. The movement of the curves AA and

Figure 3—Increase in government expenditures financed by taxes



T'T' to the right continues until a new equilibrium position is attained at P_N^2, higher than the initial one (P_N^0). In this case, an increase in government expenditure increases P_N, and the production of tradables is discouraged.

Empirical Results

To examine the effects of terms-of-trade changes and government expenditure on the real exchange rate, a real exchange rate equation (price of tradables/price of nontradables) is estimated. The real exchange rate is determined by the external terms of trade, the size of government expenditure relative to GDP, per capita real income, and the real interest rate. Government expenditure is taken relative to GDP because the important thing in determining the influence of government on relative prices is how its spending changes *in relation to* GDP rather than its absolute size. Real income is on a per capita basis because it serves as an overall measure of the extent of capital accumulation over the period and also because it is a better measure of the relative growth of aggregate demand.

An estimation of the demand for money is also presented because variations in excess demand for money affect expenditure and relative prices via the impact on interest rates.

For the empirical analysis, ordinary least squares regressions are run, and a correction for autocorrelation is done when it is present.

Relative Prices of Traded and Nontraded Commodities

The main thrust of the model presented in the first part of this chapter is the prediction that, as a result of an increase in the terms of trade (mainly an increase in the price of coffee) and an increase in government expenditure (biased toward domestic goods), the exchange rate for noncoffee sectors appreciated. In other words, the price of tradables over noncoffee tradables decreased. The estimating equation of the real exchange rate for the period 1967-83 is as follows:

$$\log P_N = \pi_0 + \pi_1 R + \pi_2 \log PCGDP + \pi_3 \log P_C + \pi_4 G (\text{or } D) + u, \qquad (23)$$

where

$\log$ = natural logarithm
P_N = price of nontraded goods relative to the price of noncoffee tradables,
R = real interest rate,
$PCGDP$ = per capita real GDP,
PC = price of coffee relative to the price of noncoffee tradables,
G = consolidated public-sector expenditure relative to nominal GDP,
D = consolidated public-sector deficit relative to nominal GDP, and
u = error term.

The estimated equations are presented in Table 11. The coefficients are significant, and the signs for the government variables (G or D) and terms of trade tend to support the hypothesis that an improvement in the terms of trade and an increase in government expenditure increase the relative price of nontraded goods. The negative effect of government expenditure on the price of noncoffee tradables also lends support to the idea that the government's propensity to spend on nontraded commodities is higher than its propensity to spend on traded commodities.

It is interesting to note that the interest rate has a positive effect on the price of nontraded goods. This indicates that policies that increase real interest rates lead, in the medium run, to a reduction in the real exchange rate, other things remaining constant. This positive effect of the interest rate on the relative price of nontraded goods is also in agreement with the presumption that increases in the interest rate will increase relative prices.

Table 11 also presents estimates based on equation (23) but for three different sets of relative prices used as dependent variables. These prices are noncoffee exportables, noncoffee agricultural exportables, and noncoffee agricultural tradable goods relative to the price of nontradables. These results support the argument of this chapter that improvements in terms of trade and increases in government expenditure reduce the real exchange rate for the noncoffee tradable sector in general as well as for the agricultural sector. For this set of regressions (equations 4-8) the variable representing

Table 11—Determinants of relative prices of noncoffee tradable and agricultural tradable commodities

Dependent Variable/ Period	Constant	Log Per Capita GDP (T−1)	Real Interest Rate (T−1)	LPC (T−1)	LTTBS (T−1)
1. LPNC (1969-83)	4.2810 (33.1333)	−0.2567 (−6.8147)	0.009 (6.4617)	0.1952 (6.6509)	. . .
2. LPNC (1968-83)	4.3518 (25.8354)	−0.1471 (−4.125)	0.0065[a] (2.5922)	0.13977 (3.0395)	. . .
3. LPXNC (1968-83)	4.9487 (23.634)	0.2347 (5.4009)	−0.0071[a] (−2.589)	−0.1828 (−3.4196)	. . .
4. LPXNC (1968-83)	5.484 (7.901)	0.716 (3.1705)	−0.0217 (−3.175)	. . .	−0.6084[a] (−2.296)
5. LPXANC (1969-83)	5.3618 (9.339)	0.9799 (5.612)	−0.0203 (−3.834)	. . .	−0.6724 (−3.3769)
6. LPXANC (1968-83)	5.4419 (10.347)	0.8200 (4.691)	−0.0239 (−4.799)	. . .	−0.712 (−3.396)
7. LPTANC 1969-83	5.6117 (10.951)	0.8029 (4.922)	−0.0168 (−3.571)	. . .	−0.6208 (−3.456)
8. LPTANC 1969-83	5.9800 (15.259)	0.7415 (5.8609)	−0.0217 (−5.5947)	. . .	−0.7273 (−4.8663)

Dependent Variable/ Period	Government Variable				R^2 Adjusted	Auto-correlation	Durbin Watson Statistic
	G(T−1)	D(−1)	G	D			
1. LPNC (1969-83)	0.42597 (3.5772)	. . .	. . .	. . .	0.911	0.34 (1.1660)	2.272
2. LPNC (1968-83)	. . .	0.359 (2.6440)	. . .	. . .	0.769	. . .	1.512
3. LPXNC (1968-83)	−0.4794[a] (−2.368)	. . .	. . .	. . .	0.6506	. . .	2.208
4. LPXNC (1968-83)	. . .	−0.6816[b] (−1.664)	. . .	. . .	0.783	. . .	1.731
5. LPXANC (1969-83)	. .	. . .	−1.1645 (−2.9747)	. . .	0.865	0.1601 (0.421)	1.588
6. LPXANC (1968-83)	. . .	. . .	. . .	−0.701[a] (−2.415)	0.822	. . .	2.12
7. LPTANC (1969-83)	. . .	. . .	−1.1811 (−3.206)	. . .	0.852	0.2134 (0.447)	1.45
8. LPTANC (1969-83)	. . .	. . .	. . .	−0.9227 (−4.005)	0.852	−0.4696 (−1.513)	2.15

Notes: LPNC is the log of the price of nontraded goods over the price of coffee. LPXNC is the log of the price of noncoffee exportables over the price of nontraded goods. LPXANC is the log of the price of noncoffee agricultural exports over the price of nontraded goods. LPTANC is the log of the price of noncoffee agricultural tradables over the price of nontraded goods. LPC is the log of the price of coffee over the price of noncoffee tradables. LTTBS is the log of the price of exports of goods and services over the price of imports of goods and services. Unless otherwise indicated, variables are significant at the 99 percent level. The numbers in parentheses are t-statistics. G is government expenditures and D is the government deficit. T-1 indicates a time lag of one year.

[a] Significant at 98 percent.

[b] Significant at 90 percent.

terms-of-trade changes is measured by the implicit price of exports of goods and services divided by the implicit price of imports of goods and services.

Relative Prices of Agricultural Output and Nontraded Commodities

Here equation (23) is used to explain the determination of relative prices for broad aggregates of agricultural products for the period 1970-83. The years 1967-69 are excluded because the information required to construct the relevant price indexes is not available. Relative prices in agriculture are measured as the ratio of the implicit price of gross output to the implicit price of nontraded goods in the nonagricultural sector.

Equation 23 is used because the level of aggregation permits it. In other words, the relative prices of agricultural products are explained by the interest rate, the terms of trade, real per capita income, and government expenditure. The estimated equations are presented in Table 12.

The first three equations in Table 12 are the estimated equations for relative prices for total agriculture. All the variables have the expected sign and except for real per capita income are significant at the 99 percent level. The nonsignificance of real per capita income arises from its opposite impact on the price of nontraded and traded goods within agriculture: negative for the first group of commodities and positive for the second. The estimated value of the coefficient for the real interest rate indicates that an increase of 1 percentage point in the interest rate produces a 2-3 percent decline in the relative prices of agricultural products. Therefore, the large increase in interest rates in the external markets in the late 1970s and early 1980s and the internal policies that led to an increase in interest rates seem to have been important factors negatively affecting agricultural incentives.

The effects of terms-of-trade changes are felt positively in the present period but negatively in the following period. This is because this set of relative prices includes coffee, which composes one third of agricultural output. This means that the Dutch-disease effect of an improvement in terms of trade (essentially of increases in coffee prices) is felt one period after this improvement has taken place. It is important to note the high absolute value of the coefficient for the size of the public-sector variable, larger than one. This means that a 1 percentage point increase in the size of the public sector reduces the relative price of agricultural output by more than 1 percentage point. This is particularly important between 1978 and 1983, when the size of the public sector increased from 29 to 39 percent of GDP. Therefore, a great proportion of the loss of competitiveness of Colombian agriculture in the late 1970s can be traced to the substantial increase in government expenditure during this period.

Equations 4 and 5 of Table 12 show the results of estimation for the relative price of noncoffee agriculture. Real per capita income is not very significant, but the rest of the variables are significant to at least a 98 percent confidence level. The nonsignificance of real income arises from its opposite effect on traded and nontraded commodities, as shown below.

Equations 6 and 7 report the results for the tradable sector of noncoffee agriculture, equations 8 and 9 present the results for the exportable sector of agriculture, and equations 10 and 11 for the importable sector of agriculture. Equations 12 and 13 present the results for the tradable part of the food sector. In this set of equations all the explanatory variables are significant and have the expected sign, and the results are similar to the ones reported in equations 4 and 5 and in Table 11.

Table 12—Determinants of relative prices in the agricultural sector

Dependent Variable/ Period	Constant	Log Per Capita GDP (T−1)	Real Interest Rate (T−1)	L TTBS		Government Variable			R^2 Adjusted	Autocorrelation	Durbin-Watson Statistic
				(T)	(T−1)	G(T−1)	G	D			
1. LPAG											
(1970-83)	5.9264	0.2697	−0.0292	0.5077	−0.9372	. . .	. . .	. . .	0.88	. . .	2.3
	(6.242)	(1.1210)	(−4.7588)	(3.3422)	(−3.713)						
2. LPAG											
1970-83	4.9301	. . .	−0.0158	0.6155	−0.6069	−1.1818[a]	. . .	. . .	0.92	. . .	2.1
	(8.875)		(−4.281)	(5.554)	(−5.521)	(−2.657)					
3. LPAG											
1971-83	5.1414	. . .	−0.02	0.5925	−0.6936	. . .	. . .	−0.7585[a]	0.93	−0.3311	2.2
	(9.943)		(−6.841)	(5.062)	(−6.718)			(−2.569)		(−0.8552)	
4. LPAGNC											
(1971-83)	7.5903	0.249[b]	−0.0199	. . .	−0.7759	. . .	. . .	−0.9529	0.90	−0.418	2.6
	(15.2805)	(1.835)	(−4.581)		(−4.596)			(−3.196)		(−1.3)	
5. LPAGNC											
1971-83	7.43784	0.2671[c]	−0.0155	. . .	−0.6900	. . .	−1.55[a]	. . .	0.90	. . .	1.8
	(12.821)	(1.6709)	(−2.947)		(−3.609)		(−2.806)				
6. LPTAN1											
(1971-83)	6.5274	0.66[a]	−0.019	. . .	−0.7337	. . .	−1.0894[c]	. . .	0.83	0.1743	1.8
	(9.3807)	(2.818)	(−3.211)		(−3.268)		(−2.169)			(0.719)	
7. LPTAN1											
(1971-83)	6.4912	0.6806	−0.0228	. . .	−0.7992	. . .	. . .	−1.055	0.82	−0.393	2.1
	(12.254)	(4.2706)	(−4.583)		(−4.136)			(−3.332)		(−1.088)	
8. LPXAN1											
(1970-83)	6.1034	0.954	−0.0282	. . .	−0.8798	. . .	. . .	−0.89[a]	0.82	. . .	2.3
	(8.375)	(4.374)	(−4.624)		(−3.446)			(−2.492)			
9. LPXAN1											
(1971-83)	6.1464	0.9528	−0.023	. . .	−0.816	. . .	−1.2658[a]	. . .	0.84	. . .	1.6
	(8.6208)	(4.849)	(−3.538)		(−3.472)		(−2.502)				
10. LPMAG											
(1971-83)	7.9733	0.2822[a]	−0.0172	. . .	−0.8793	. . .	. . .	−0.8968	0.91	−0.611[b]	2.4
	(21.166)	(2.698)	(−5.077)		(−6.714)			(−4.156)		(−2.11)	
11. LPMAG											
(1970-83)	7.5693	0.3458[b]	−0.0127[b]	. . .	−0.7649	. . .	−1.2058	. . .	0.87	. . .	2.1
	(13.683)	(2.241)	(−2.382)		(−3.962)		(−3.046)				

(continued)

Table 12—Continued

Dependent Variable/ Period	Constant	Log Per Capita GDP (T−1)	Real Interest Rate (T−1)	LTTBS		Government Variable			R^2 Adjusted	Autocorrelation	Durbin-Watson Statistic
				(T)	(T−1)	G(T−1)	G	D			
12. LPAGFT (1970-83)	6.458 (11.181)	0.6282 (3.634)	−0.0223 (−4.619)	. . .	−0.7633 (−3.771)	. . .	. . .	−0.8817 (−3.114)	0.84	. . .	2.4
13. LPAGFT (1971-83)	6.301 (8.635)	0.5842^b (2.16)	−0.0168 (−2.932)	. . .	-0.6387^b (−2.806)	. . .	-1.145^a (−2.217)	. . .	0.83	0.304 (0.535)	1.6
14. LPC1 (1971-83)	1.2608^b (1.994)	. . .	−0.0237 (−4.948)	1.8985 (12.06)	−1.0598 (−7.197)	−1.6502 (−2.958)	. . .	. . .	0.96	−0.473 (−1.304)	1.9

Notes: Unless otherwise indicated, variables are significant at the 99 percent level. Log TTBS = terms of trade, G = consolidated government expenditure relative to nominal GDP, D = consolidated government deficit relative to nominal GDP, PAG = price of broad agriculture relative to nontraded goods in nonagriculture, PAGNC = price of noncoffee agriculture relative to nontraded goods in nonagriculture, PTAN1 = price of noncoffee agricultural tradables relative to nontraded goods in nonagriculture, PXAN1 = price of noncoffee agricultural exportables relative to nontraded goods in nonagriculture, PMAG = price of agricultural importables relative to nontraded goods in nonagriculture, PAGFT = price of agricultural food tradables relative to nontraded goods in nonagriculture, and PC1 = price of coffee relative to nontraded goods in nonagriculture.

[a] Significant at 98 percent.

[b] Significant at 95 percent.

[c] Significant at 90 percent.

The estimated equation for the relative price of coffee is equation 14 in Table 12. Coffee is a slightly different case from the previous ones because of the effects of terms of trade and real income. The variables indicated in equation (23) explain more than 90 percent of the variation in coffee prices, but real income is insignificant. Therefore, real interest rate, contemporaneous and lagged terms of trade, and government size are used as independent variables. The contemporaneous effect of terms of trade is positive but the lagged effect is negative. Thus, only one period after the improvement in terms of trade has taken place the Dutch disease effect of the increase in coffee prices begins to emerge in that sector. However, the total effect of increases in the international terms of trade is positive, in contrast with the rest of agriculture, where it is negative. One explanation for the negative sign of the interest rate is that when this rises, the cost of holding stocks increases, so that there is an incentive to release stocks and reduce prices. Another way of looking at this result is that when the interest rate goes up, coffee prices are held down to avoid an excessive accumulation of stocks and an increase in the cost of holding them.

The demand for money was relevant when the determinants of the interest rate in a semiopen economy in the short term were discussed. Therefore, it is important to establish whether the demand for money responds to interest rate changes. To estimate the demand for money, the following estimating equations are used:

$$m^d = \lambda_0 + \lambda_1 Y - \lambda_2 i + u, \tag{24}$$

$$m^d = \lambda_0 + \lambda_1 Y - \lambda_2 i + \lambda_3 m^d_{t-1} + u, \tag{25}$$

and

$$m^d = \lambda_0 + \lambda_1 Y - \lambda_2 i + \lambda_4 TT + u, \tag{26}$$

where

$m^d = M^d/P$ = real demand for money,
TT = terms of trade, and
u = random term.

The reason for incorporating the terms of trade is that changes in them are essentially temporary, and since the gain in income is expected to be transitory, part of it will be associated with an increase in the level of savings, which in part is reflected in the accumulation of real cash balances. Therefore, the sign for the terms-of-trade variable is expected to be positive.

All the variables in equations (24) to (26) are in logarithms, except for the nominal interest rate. The results of estimation are reported in Table 13. The estimated coefficients have the expected signs and are highly significant.

Capital Mobility

Next the extent of capital mobility in Colombia is established using two different tests. In equations (18) and (20) it is postulated that the domestic interest rate is determined by the external interest rate, the rate of devaluation, and domestic monetary policy. To estimate this model, the rate of inflation is taken as the variable reflecting the domestic conditions on the monetary policy side. The estimating equations are

$$i = \alpha_0 + \alpha_1 i^* + \alpha_2 \hat{e} + \alpha_3 \pi + u, \tag{27}$$

Table 13—Demand for money

Variable	Equation			
	1	2	3	4
GDP				
(T)	. . .	0.62262[a] (11.0474)	. . .	. . .
(T−1)	0.68289[a] (16.2421)	. . .	0.4907[a] (9.4275)	. . .
Per capita GDP				
(T−1)	. . .	. . .	. . .	0.2591[c] (2.4194)
Interest rate				
(T)	. . .	−0.00321[b] (−1.9909)	−0.0269[c] (−2.307)	−0.0045[a] (−2.9857)
(T−1)	−0.00593 (−5.1811)	. . .	. . .	. . .
Terms-of-trade (−1)	. . .	. . .	0.233[a] (4.8458)	. . .
Log per capita real money	. . .	. . .	. . .	0.5487[a] (3.1237)
Adjusted R^2	0.97	0.96	0.98	0.73
Autocorrelation	. . .	0.3837	. . .	. . .
Durbin-Watson or Durbin-h	2.48	1.45	1.60	0.67[d]

Notes: All the variables except the interest rate are expressed in logarithms. The dependent variable is the log of the real quantity of money except for equation (4), which is per capita real quantity of money. The period covered is 1968-83 except for equation (2), which is 1969-83.

[a] Significant at 99 percent.

[b] Significant at 98 percent.

[c] Significant at 98 percent.

[d] Durbin-h.

and

$$i = \beta_0 + \beta_1[i^*(1 + \hat{e})] + \beta_2\pi + u, \tag{28}$$

where

i^* = external rate of interest,
$\hat{e}$ = rate of devaluation, and
π = domestic rate of inflation.

The first equation introduces the effects of the foreign interest rate and the rate of devaluation separately, while the second one introduces these effects in one single element, the parity rate $i^*(1 + \hat{e})$. The foreign interest rate is approximated by the London Interbank Offering Rate (LIBOR). The estimated equations are presented in Table 14 and cover the period 1967-83. The results point to a strong link between the domestic and international capital markets and to a large and decisive influence of the parity rate on the domestic interest rate. Thus, despite restrictions on international capital movements, people and businesses move capital in and out of the country. Also, the results support the idea that at least in the short run there is some room for autonomous monetary policy.

Two points about the results presented in Table 14 are worth noting. First, the estimated coefficients of equation 1 in the table indicate that the influence of the parity rate on the domestic interest rate is stronger than the influence of inflation. Second, the estimated coefficients in equation 2 indicate that the influence of the external rate of interest on the domestic interest rate is stronger than that of the rate of devaluation, that is to say, a 1 percent increase in the foreign rate of interest is reflected in the domestic rate of interest by the same amount, while a 1 percentage point increase in the rate of devaluation affects domestic interest rates by half a percentage point.

Table 14—Determinants of the domestic interest rate, 1967-83

Independent Variable	Nominal Interest Rate Equation 1	 Equation 2
Constant	−4.30690 (−1.8273)	−5.86710[a] (−2.4659)
External interest rate	. . .	1.16138[a] (4.8140)
Rate of devaluation	. . .	0.68639[a] (5.3836)
Parity rate	0.74377[a] (8.3086)	. . .
Domestic rate of inflation	0.59370[a] (5.6967)	0.55500[a] (5.3013)
Adjusted R^2	0.90	0.91
Durbin-Watson statistic	2.02	2.27

Note: The numbers in parentheses are t-statistics.

[a] Significant at 99 percent.

Change in Reserves

The change in reserves is the consequence of changes in the current and capital accounts. From this perspective it can be said that real per capita GDP, the price and quantity of coffee, and the government deficit are important factors in the determination of the current account and that the interest rate differential is the main force behind the capital account. All these factors are also important in the money market. To examine their influence on the accumulation of reserves, the following test is used. The relationship of change in international reserves to high-powered money is used as a dependent variable. On the other hand, the GDP, the terms of trade, the volume of coffee exports, and the differential in the domestic and external interest rates are the independent variables.[24] The estimating equation is

$$\delta R/H = \alpha_0 + \alpha_1 \ln PCGDP + \alpha_2\{i/[i^*(1+\hat{e})]\} + \alpha_3 \ln P_C + \alpha_3 \ln XC, \qquad (29)$$

where

δR = change in international reserves (in pesos),
H = high-powered money or monetary base, and
XC = volume of coffee exports.

The results from the estimation of equation (29) are presented in Table 15. From this table, the obvious role played by real income, terms of trade, and volume of coffee exports is clear. However, it is also important to note the role of the interest rate differential in the accumulation of reserves through the capital account, which strengthens the previous findings that there is a strong international mobility of capital in Colombia.

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[24] This is a modified version of a test suggested by Dornbusch in *Open Economy Macroeconomics.*

Table 15—Determinants of changes in international reserves and the extent of capital mobility

Independent Variable	Change in Reserves Relative to Money Base Equation 1	 Equation 2
Constant	5.4307[a] (2.132)	5.3259 (1.762)
Log real GDP (−1)	−1.1021[b] (−4.228)	−1.1883[b] (−2.924)
Interest rate differential	0.069 [b] (3.548)	0.0537[b] (2.708)
Log coffee price (T−1)	0.719[b] (2.919)	. . .
Log terms-of-trade	. . .	1.2203[c] (1.8503)
Log volume of coffee exports (T−1)	1.1928[b] (4.069)	0.9442[c] (2.5233)
Adjusted R^2	0.66	0.567
Autocorrelation	−0.489 (−1.569)	. . .
Durbin-Watson statistic	2.29	1.978

Note: The numbers in parentheses are t-statistics.
[a] Significant at 95 percent.
[b] Significant at 99 percent.
[c] Significant at 98 percent.

Conclusions

The profitability and production of noncoffee tradables were subject to substantial negative pressures in the Colombian economy between 1975 and 1983. These pressures arose mainly from the decrease in the real exchange rate (relative price of noncoffee tradables/nontradables) induced by the increase in the terms of trade and later by the growing fiscal expenditure and deficit. Given the increasing mobility of capital in Colombia, fiscal pressures on the real exchange rate are stronger in the long than in the short run due to the effects of additional capital inflows induced by the potential pressure of the deficit on domestic interest rates.

The results, which were presented in some detail in the previous sections on the determinants of relative prices, explain to a large extent the observed decline in agricultural incentives between 1975 and 1983. These regressions do not include a nominal variable; they explicitly leave out the rate of devaluation as a determinant of relative prices in the economy. The rate of devaluation was tried as an explanatory variable to establish whether it would, in fact, affect relative prices, but it turned out to be insignificant.

5

SUPPLY RESPONSE IN COLOMBIAN AGRICULTURE

This chapter examines the supply response of Colombian agriculture, which is an important issue because a large share of Colombian agriculture is tradable and, hence, the price of agricultural output largely depends on the real exchange rate.

Brief Review of Studies

In the early stages of the import substitution models, it was thought that output in agriculture was not responsive to price incentives. From this point of view, agricultural exports would be exogenous and independent of variables like the real exchange rate or the tariff level. Therefore, a devaluation to correct balance-of-payments disequilibria would essentially be reflected in an acceleration of inflation. Inflation in itself was viewed as a structural phenomenon, arising from insufficient food supplies resulting from a low supply response of agricultural output and a growing demand for food generated by an increase in per capita income. Thus, inflation became a brake on the process of industrialization.

A number of studies on supply response have changed this vision of the world. Moreover, because most of these studies measure area response, total response is underestimated because the responses of labor and capital, especially the latter, are omitted. Thus, when capital and labor responses are considered, the long-run elasticity of supply may be close to or larger than one.[25]

In the Colombian case a number of studies on agricultural supply response were done in the 1960s and 1970s,and it was found that the supply response was positive and significant in both the short and long runs, both for commercial commodities, such as cotton, sugarcane, coffee, bananas, wheat, sorghum, and soybeans, and traditional ones, such as cassava, beans, and maize.[26]

The structuralist argument that inflation is caused by insufficient supply response of agricultural products has not been supported by the empirical evidence so far. If the structuralist argument is valid at all, it would be so only in the short run because the response of agricultural products to changes in prices is quite significant in the medium and long runs. Moreover, there is a problem of causation: it is not clear whether agriculture stops industrialization because the supply response is low or whether the industrial protection policy causes the stagnation of agricultural output by reducing incentives to agriculture.

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[25] See, for example, Domingo Cavallo, "Exchange Rate Overvaluation and Agriculture: The Case of Argentina," a document prepared for a World Development Report, Buenos Aires, September 1985 (mimeographed).

[26] For a summary of the results of the major studies, see Roberto Junguito, "Precios Agrícolas, Producción y Asignación de Recursos: La Experiencia Colombiana," *Coyuntura Económica* 10 (April 1980): Tables 3 and 5.

Supply Response for Individual Products

To estimate the supply response for annual or semiannual crops the Nerlove partial adjustment model is used.[27] In this model, area in the present period is a function of prices in the current or past period, area lagged one period, and supply shifters. That is,

$$X_t = c_o^t \alpha\beta P_{t-1} + (1-\alpha)X_{t-1} + \sigma Z_t + U_t, \tag{29}$$

where

X_t = area cropped in time t,
P_{t-1} = price of the crop in period $t-1$,
Z_t = a supply shifter,
$\alpha\beta$ = short-term elasticity of supply,
β = $\alpha\beta/[1-(1-\alpha)]$ = long-term elasticity of supply, and
U_t = error term.

The procedure followed to estimate the elasticity of supply for each product will now be described.

Cotton

Cotton is produced in four regions: Costa, Meta, Tolima, and Valle. The cropping season for Costa is the same as for Meta, and the cropping season for Tolima is the same as for Valle. These four regions are usually classified as two regions, Costa-Meta and Interior (Tolima and Valle). Three of the regions, Costa, Meta, and Tolima, produce short-fiber cotton, while Valle has produced long-fiber cotton since 1967. In general, expansion of cotton output has been easier in the Costa-Meta region than in the Interior, where more crops compete for the use of land than in the Costa-Meta region.

Equation (29) is used to estimate the supply response of cotton for each region. The dependent variable is the number of hectares cropped, and the supply shifter is the deviation of yield (tons of raw cotton per hectare) around its trend value, for the region or for the country as a whole. To estimate equation (29), area and prices are expressed in logarithms. For Costa-Meta the price of raw cotton or the price of fiber relative to the price of nonagricultural products (PNA) is used as the price variable, as well as the price of meat relative to fiber. For Valle the price of soybeans relative to the price of cotton fiber is used. Finally, for the country as a whole, the price of raw cotton and the price of fiber relative to the price of nonagricultural products are used. Regressions are run for Costa-Meta, the Interior, Tolima and Valle separately, and the whole country. Results are reported in Table 16 only for Costa-Meta, Valle, and the country as a whole because the regressions run for the Interior and Tolima produced unsatisfactory results.

The statistical results are satisfactory, and the coefficients have the expected signs. For each regression the own price elasticity of supply of cotton is calculated. According to the results presented in Table 16, the short-run response of area in the Costa-Meta region is close to 1.0 while the long-run supply response is about 4.0. For Valle, the

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[27] See Marc Nerlove, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities," *Journal of Farm Economics* 38 (May 1956): 496-509.

Table 16—Logarithmic regressions for estimating the supply response of cotton

Variable	Costa-Meta	Valle	Total Country
	1962-84	1961-83	1960-84
Constant	−2.374 (−0.963)	3.312 (3.644)	−1.418 (−0.703)
Area (T−1)	0.778 (6.674)	. . .	0.739 (5.885)
Trend variability of yield (T−1)	0.907 (2.476)	. . .	0.768 (2.286)
Relative prices			
Raw cotton/PNA (T−1)	. . .	. . .	0.960 (2.801)
Fiber/PNA (T−1)	0.892 (2.236)	. . .	. . .
Soybean/fiber (interior) (T−1)	. . .	−2.691 (−5.116)	. . .
Soybean/fiber (interior) (T)	. . .	−1.229 (−2.376)	
R^2	0.74	0.69	0.71
Durbin-Watson statistic	1.83	1.81	1.75
Durbin-h	0.50	0.46	0.82
Long-term supply elasticity	4.02	. . .	3.68

Notes: The numbers in parentheses are t-statistics. The dependent variable is total cultivated area in hectares. PNA is the price of nonagricultural products. The regressions for the variability of yield around the trend are as follows: for Costa Meta, −0.119 + 0.021 Time; for Valle, 0.463 + 0.011 Time; and for the total country, 0.036 + 0.017 Time.

short-run price elasticity is 1.3 for contemporaneous changes in relative prices and 2.7 for changes in relative prices lagged one year. No long-run price elasticity is calculated for Valle because area lagged one year was not significant. For the country as a whole, the short-term elasticity of supply is also close to 1.0, while the long-term elasticity is about 3.7. This high supply response of cotton may be due to the increasing importance of the Costa-Meta region in cotton production in Colombia. In this region, a significant increase in cotton production has taken place through the expansion of area, mainly through clearing of land or the use of land previously devoted to cattle. Although the values of the long-run elasticity of cotton estimated in this report are probably high compared with those estimated for other countries, these values are lower than the corresponding estimates of Palma (14.8) and Fundación para la Educación Superior y el Desarrollo (FEDESARROLLO) (19.4), as reported by Junguito.[28]

Rice

Rice is produced mainly in four regions: Huila, Tolima, Costa, and Meta, under two different technologies, irrigated and upland. The production of rice increased over time as a result of a successful research program that started in 1957 and the introduction of irrigation in the 1960s. After 1966, a marked increase in yields is observed due to adoption of new rice varieties.[29] To estimate the supply response of rice, total cultivated area in hectares is taken as the dependent variable. The contemporaneous domestic price of paddy relative to the price of nonagricultural output, area lagged one period, and the ratio of irrigated area to total cropped area in rice—the supply shifter—are the independent variables. Area and price are expressed in logarithms. The regressions cover the 1961-83 period and the results are presented in Table 17.

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[28] Junguito, "Precios Agrícolas."

The estimated short-term price elasticity reported here—between 0.36 and 0.48—is higher than previous estimates. For the short-term supply response Gutiérrez and Hertford estimate an elasticity of 0.213; Montes, Candelo, and Muñoz obtain a value of 0.26; and Hall estimates a value of 0.1.[30] The long-run supply elasticity is higher than one, and at least one-third of the total price effect takes place during the first year. Compared with cotton, the estimated value of the long-run elasticity of supply is much lower, 3.7 in cotton and 1.3 in rice, but the total effect of a price change takes place faster in rice. Whereas in rice the total effect of a price change can be felt in less than 6 years, in cotton that effect can take up to 20 years.

Wheat

Wheat is produced in three regions: Boyacá, Cundinamarca, and Nariño. For some time, the production of wheat increased due to the positive effects of a research program started in 1926. Colombia's wheat research program received important assistance from a number of foreign and national organizations. The Rockefeller Foundation was one important source of support until the mid-1960s; other sources were the National Institute of Supplies (Instituto Nacional de Abastecimientos—INA) and some of the farmers' federations, especially the National Federation of Cereal Producers (FENALCE). Despite these efforts in research and the introduction of new varieties in the 1950s and mid-1960s, cultivated area and output have declined sharply. Cultivated area fell steadily from 175,000 to 46,000 hectares between 1953 and 1983. However, yield per hectare increased from 800 to 1,680 kilograms during this period. One of the explanations given for the decrease in acreage planted is the effect of U.S. foreign aid P.L. 480 sales on producer incentives.[31] Although this interpretation may be correct, it is important to point out that area planted continued falling even after P.L. 480 was phased out.

To estimate the supply response of wheat, both output and area are used as dependent variables. The producer price relative to the price in the nonagricultural sector or to the price of milk is taken as an independent variable. Area, output, and price are expressed in logarithms. Various supply shifters are used: the share of P.L. 480 wheat imports in total wheat production, credit, public research expenditures, and the share

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[29] An analysis of the profitability of the generation of the new rice technology in Colombia is found in Reed Hertford, et al., "Returns to Agricultural Research Investment in Colombia" in *Resource Allocation and Productivity: National and International Agricultural Research*, ed. Thomas Arnd, D. Dalrymple, and Vernon Ruttan (Minneapolis: University of Minnesota Press, 1977). Also see J. Ardila, *Rentabilidad Social de las Inversiones en Investigación de Arroz en Colombia* (M.S. thesis, ICA-Universidad Nacional, 1973).

[30] See N. Gutiérrez and Reed Hertford, *Una Evaluación de la Intervención del Gobierno en el Mercado de Arroz en Colombia*, Centro Internacional de Agricultura Tropical, Folleto Técnico No. 4 (Cali: CIAT, 1974), Table 3; Gabriel Montes, Ricardo Candelo, and Ana Milena Muñoz, "La Economía del Arroz en Colombia," *Revista de Planeación y Desarrollo* (January-April 1980): 115; and Lana Hall, *The Effects of P.L. 480 Wheat in Latin American Countries*, California Agricultural Experiment Station, Giannini Foundation of Agricultural Economics, University of California at Berkeley, September 1978, p. 46.

[31] See Leonard Dudley and Roger J. Sandilands, "The Side Effects of Foreign Aid: The Case of Public Law 480 Wheat in Colombia," *Economic Development and Cultural Change* 23 (January 1975): 325-337.

Table 17—Logarithmic regressions for estimating the supply response of rice

Equation	Period	Constant	Area (T−1)	Rice/PNA	Share of Irrigated Area in Cultivated Area		R^2	Durbin-h	Long-Term Elasticity of Supply
					(percent)	(log of percent)			
1	1961-83	−0.010 (−0.099)	0.667 (5.932)	0.417 (2.179)	0.008 (3.000)	...	0.82	0.83	1.25
2	1961-83	−1.26 (−0.899)	0.744 (6.686)	0.359 (1.779)	...	0.346 (2.496)	0.80	0.76	1.40
3	1961-81	−0.218 (−0.194)	0.673 (5.292)	0.434 (2.061)	0.008 (2.870)	...	0.79	0.65	1.33
4	1961-81	−1.539 (0.966)	0.755 (5.945)	0.387 (1.746)	...	0.375 (2.465)	0.77	0.55	1.58
5	1961-78	−0.097 (0.079)	0.617 (3.864)	0.481 (2.105)	0.003 (2.762)	...	0.69	0.55	1.26

Notes: The numbers in parentheses are t-statistics. The dependent variable is total cultivated area in hectares. PNA is the price of nonagricultural products.

of purchases of wheat by the Institute for Agricultural Marketing (IDEMA) in total wheat production, but these variables turned out to be statistically insignificant. The estimated equations are presented in Table 18.

When the information for the 1950-83 period was used to estimate the supply response of wheat, the statistical results were not satisfactory. Thus, the results reported for two different periods, 1951-72 and 1955-83, are the best ones that could be obtained with the information and specifications used. What comes out of the results is that the price of wheat over the price of nonagriculture, current or lagged one period, is quite significant: the estimated short-term elasticity of area with respect to price varies between 0.38 and 0.45, while the short-term response of output to price changes seems to be higher, around 0.7. The elasticity of wheat output with respect to the relative price of wheat to milk is low and significant but with a lag of five years. The estimated long-term price elasticity varies between 2.2 and 3.3 for area, and it is 1.4 for output. The estimated values are lower than those obtained by Dudley and Sandilands or Junguito, but higher than the value estimated by Palma as reported in Junguito. In any case, these values show that wheat producers respond positively to changes in prices and that their response is as high as the one for rice.

Coffee

Because coffee is a perennial plant, the decisions to plant, uproot, and maintain or increase the productivity of the existing capital stock require a more complex and complete model than the one represented by equation (29). Although some efforts have been made to analyze the supply response of perennials with a modified and more complete framework, this has not been the case for coffee in Colombia.[32] There

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[32] See, for example, Michael Hartley, Marc Nerlove, and R. K. Peters, Jr., *The Supply Response for Rubber in Sri Lanka,* World Bank Staff Working Paper No. 657 (Washington, D.C.: World Bank, 1984). A discussion of the limitations of the Nerlove partial-adjustment model for estimating the supply response in the case of perennials is presented in Marc Nerlove, "The Dynamics of Supply: Retrospect and Prospect," *American Journal of Agricultural Economics* (December 1979): 874-888.

Table 18—Logarithmic regressions for estimating the supply response of wheat

Dependent Variable/ Period	Constant	Area (T−1)	Output (T−1)	Relative Prices			R²	Durbin-h	Long-Term Elasticity of Supply
				Wheat/PNA (T)	Wheat/PNA (T−1)	Wheat/ Milk (T−5)			
1. Area									
(1951-72)	−1.221	0.859	...	0.456	...	...	0.92	0.24	3.2
	(−1.965)	(7.787)		(2.002)					
2. Area									
(1951-72)	−1.049	0.883	...	...	0.383	...	0.92	1.19	3.3
	(−1.684)	(7.820)			(1.684)				
3. Output									
(1951-72)	−0.504	...	0.514	...	0.684	...	0.64	0.81	1.4
	(−0.524)		(2.776)		(2.346)				
4. Area									
(1955-83)	0.386	0.877	...	...	...	0.275	0.96	1.15	2.2
	(1.803)	(15.119)				(1.728)			

Notes: The numbers in parentheses are t-statistics. PNA is the price of nonagricultural products.

have been estimates of the supply response of coffee in Colombia using a distributed lags analysis framework with modifications, but the complexity introduced does not seem worth the effort if similar results can be obtained using simpler partial-adjustment models.[33] In fact, more recent attempts have used the simplest of partial-adjustment models, based on information on new plantings and replantings with the new, high-yielding *caturra* variety.[34] These studies have obtained a higher supply response than earlier ones, for one important reason: the *caturra* variety bears fruit after a shorter time.

Since the purpose of this report is not to make a comprehensive revision and estimation of the supply response of Colombian agriculture, the report builds on the information generated by existing studies to estimate the supply response of coffee using the simple framework of a partial adjustment model. The only data sets found to be useful are Bateman's and Zambrano's.[35] The Bateman series covers the period 1936-65, while the Zambrano series covers 1970-83. Junguito's data are not used because the published series covers a shorter period than the one for which he reports results. Since Junguito's results could not be replicated, his information was discarded.[36] The series in Bateman has the advantage of being readily available with a relatively large number of observations (30), and they cover the period 1936-65.

The estimates made using the Bateman series are presented in Table 19. All the estimations were based on the simple model of equation (29), and only one equation

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[33] Models that estimate the supply response of coffee in Colombia using a modified version of Nerlove's partial-adjustment model include Merrill J. Bateman, *Supply Response in the Colombian Coffee Sector,* Memorandum RM-5780-RC/AID (Santa Monica, Cal.: Rand Corporation, 1969); and Roberto Junguito, "Un Modelo de Respuesta en la Oferta de Café en Colombia," Fundación Para la Educación Superior y el Desarrollo, Bogotá, July 1974 (mimeographed).

[34] The *caturra* is a high-yielding variety that was introduced in the coffee-growing areas of Colombia in the early 1970s. Two recent studies that estimate the supply response of coffee using information on area planted with caturra varieties are T. Akiyama, "Analysis of Coffee Policy Instruments and Supply Response in Colombia," World Bank, Washington, D.C., June 1985 (mimeographed); and Hernán R. Zambrano, "Tendencias de la Caficultura Colombiana," *Economía Colombiana* (March 1986): 34-46.

[35] Bateman, *Supply Response in Colombian Coffee;* and Zambrano, "Tendencias de la Caficultura Colombiana."

[36] Junguito, "Un Modelo de Respuesta."

Table 19—Logarithmic regressions for estimating the supply response of coffee

Dependent Variable/ Period	Constant	Price of Coffee			Output of Coffee	Change in Output	Adjusted $\bar{R}^2$	Durbin-Watson Statistic	Durbin-h
		T−5	T−6	T−7	T−1	T−1			
1. Coffee output (1944-65)	2.2597	0.1684	. . .	. . .	0.5002	. . .	0.82	1.91	0.29
	(3.1578)	(2.9911)			(3.3757)				
2. Coffee output (1940-65)	1.2426	0.1068	. . .	. . .	0.7138	. . .	0.85	2.06	−0.17
	(2.5460)	(2.1728)			(7.033)				
3. Coffee output (1941-65)	1.7288	. . .	0.1309	. . .	0.6162	. . .	0.83	2.34	−1.06
	(3.111)		(2.4693)		(5.221)				
4. Coffee output 1942-65	2.2513	. . .	. . .	0.1612	0.5078	. . .	0.81	1.79	0.80
	(3.2504)			(2.6572)	(3.4169)				
5. Coffee output (1944-65)	4.4718	0.1203	. . .	0.2237	. . .	0.4465	0.90	2.37	. . .
	(32.423)	(2.4420)		(4.7236)		(3.2066)			

Notes: All coefficients are significant at 99 percent. The numbers in parentheses are t-statistics. T indicates the number of years lagged.

was estimated using the supply shifter, the change in the logarithm of output in the previous period.[37] The price variable only became significant when five, six, or seven years' lag was introduced. For some regressions, the simultaneous use of prices lagged five and seven years turned out to be significant, as well as the use of a supply shifter variable (change in output). The supply shifter variable had a positive sign, which is contrary to what is argued by Bateman but in agreement with Junguito.[38] From the values reported for the price and output coefficients, short- and long-run price elasticities of 0.25 and 0.40 are derived.

A Model of the Livestock Sector

To study the supply response of the livestock sector, a demographic model is used to generate stocks of male and female animals of different ages.[39] This model is presented in Appendix 2. The size of the herd estimated with this demographic model is then used to examine the response of sales (slaughter plus exports) to changes in the prices of beef, crops, and income.

In countries where extensive grazing is the main feeding system, it is to be expected that the short-run elasticity of supply (sales) will be negative, while the long-run elasticity will be positive. This is because animals are a capital good, and an increase in the price of beef increases the present value of animals, thereby inducing ranchers to retain more animals with the purpose of selling them for slaughter at a future date.[40] Thus, it is expected that the short-run elasticity of supply of female animals will be negative, while that elasticity can be negative or positive for males. The short-run elasticity for male sales may be positive at times because an increase in price increases the present value of female animals proportionally more than that of male animals, and as the size of the herd increases, feed may be insufficient, thus inducing farmers to sell more male animals. As the capital price of female animals includes the price of future births, the short-run elasticity of sales is higher for female than for male animals. In addition, in the short run, when grazing land is limited, entrepreneurs will slaughter more male and fewer female animals. However, if grazing land is available and a larger herd can be fed with the existing feed, both male and female sales will drop in the short run; in the long run, a rise in the price of beef will lead to larger herd sizes and levels of sales.[41]

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[37] There seems to be some relationship between output in the previous and present periods. For a discussion of this relationship see Bateman, *Supply Response in Colombian Coffee,* ch. 3.

[38] Junguito finds in his regressions a positive sign for the coefficient of the variable change in output (see Junguito, "Un Modelo de Respuesta").

[39] This section is based (with corrections) on Jorge García García, "The Economics of the Livestock Sector in Colombia: 1957-1977," International Food Policy Research Institute, Washington, D.C., 1980 (mimeographed).

The price of feed also affects sales of male and female animals differently. Because of the longer life span of females, an increase in feed prices reduces the capital value of female animals by more than that of male animals. Therefore, short- and long-run (positive) price elasticities of sales with respect to feed prices are higher for female than for male animals.

Finally, the rate of interest also affects the flow of sales and the size of the herd in the long run. A higher interest rate reduces the capital price of male and female animals, inducing a higher level of sales in the short run and a lower one in the long run, because in the final equilibrium position, the desired stock of animals is lower than the initial one.

Thus, to summarize, let P be the price of beef, P^c the price of feed or of crops that compete with cattle for the use of land, and r the rate of interest. Let MS_t stand for male sales and MH_t stand for the male herd in period t, and FS_t for female sales and FH_t for the female herd in period t. Then

$$MS_t = f(P_t, P^c_t, r, MH_{t-1}), \tag{30}$$

$$FS_t = g(P_t, P^c_t, r, FH_{t-1}), \tag{31}$$

and

$$(\partial MS_t/\partial Pt) > < 0,\ (\partial MS_t/\partial P^c_t) > 0,\ (\partial MS/\partial r) > 0,\ (\partial MS_t/\partial MH_{t-1}) > 0,$$

and

$$(\partial FS_t/\partial Pt) < 0,\ (\partial FS_t/\partial P^c_t) > 0,\ (\partial FS/\partial r) > 0,\ (\partial FS_t/\partial FH_{t-1}) > 0.$$

Letting ϵ_{MP} and ϵ_{MPc} denote the short-run elasticity of supply of male sales with respect to beef and to crop prices, and letting ϵ_{FP} and ϵ_{FPc} denote the same elasticities for females, then

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[40] For an exposition of the theory of investment behavior in the cattle industry, see Raul Yver, *The Investment Behavior and the Supply Response of the Cattle Industry in Argentina* (Ph.D. dissertation, University of Chicago, 1971), ch. 2; and Lovell S. Jarvis, "Cattle as Capital Goods and Ranchers as Portfolio Managers: An Application to the Argentina Cattle Sector," *Journal of Political Economy* 82 (May/June 1974). See also, Marc Nerlove, D. M. Grether, and J. L. Carvalho, *Analysis of Economic Time Series: A Synthesis* (New York: Academic Press, 1979), ch. 14. An application to Colombia is by Libardo Rivas and Alberto Valdés, "Variaciones en la Existencias de Ganado Un Enfoque Econométrico," *Revista de Planeación y Desarrollo* (May/August 1978). For a simpler framework also applied to Colombia, see Reed Hertford and Gustavo Nores, *Caracterización del Sector Ganadero de Colombia: 1953-1975* (Cali, Colombia: Centro Internacional de Agricultura Tropical, 1982).

[41] But, when intensive feeding systems are in operation there is no reason to expect a negative short-run supply elasticity of sales.

$$\epsilon_{MP} < \epsilon_{FP},$$

and

$$\epsilon_{MPc} < \epsilon_{FPc}.$$

Also, if ϵ_{MH} and ϵ_{FH} denote the elasticity of supply of male and female sales with respect to the male and female herd, it should be expected that

$$\epsilon_{MH} = \epsilon_{FH} = 1.$$

For testing the above hypotheses, the variables used are number of animals sold and price per animal.[42]

To estimate the short-run supply response of male, female, and total sales to price changes the following general-form estimating equations were used:

$$\ln MS_t = \alpha_0 + \beta_0 \ln P_{t-J} + \gamma_0 \ln P^c_{t-k} + \lambda_0 \ln MH_{t-1}, \qquad (32)$$

$J = 0,3,4$, and $k = 0,1$
for male sales;

$$\ln FS = \alpha_1 + \beta_1 \ln P_{t-J} + \gamma_1 \ln P^c_{t-k} + \lambda_1 \ln FH_{t-1}, \qquad (33)$$

$J = 0,3,4$, and $k = 0,1$
for female sales; and

$$\ln TS_t = \alpha_2 + \beta_2 \ln P_{t-J} + g_2 \ln P_{t-k} + \lambda_2 \ln TH_{t-1}, \qquad (34)$$

$j = 0,3,4$, and $k = 0,1$
for total sales

The price variable is the price of male animals sold in the Medellín stockyards, expressed in constant prices of 1952, with the wholesale price index used as the deflator. The price of cotton, current and lagged, is used as the representative crop price. The results of the estimations are presented in Table 20.

Regression equations (1 – 4), (7 – 10), and (13) in Table 20 express sales as a function of the current price of beef and the stock of animals at the end of the previous period. The estimated coefficients have the expected signs and are significant at 99 percent. As expected, the absolute value of the price elasticity of supply for current price changes is higher for female sales (between –0.45 and –1.16) than for male sales (between –0.2 and –0.3), and the elasticity of sales with respect to herd is not significantly different from one.

Regression equations (3), (4), (9), and (10) in Table 20 present estimates for the male and female sales equations incorporating the price of crops as an additional

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[42] When looking at the supply response of the livestock sector the interest is in the supply of beef rather than in the number of cattle; therefore, the dependent variable should be expressed as weight and the independent variable as price per unit of weight. However, this information is not available for most of the period.

Table 20—Short-run supply elasticity of male, female, and total sales of cattle, 1945-75

Dependent Variable	Constant	P_t	P_{t-3}	P_{t-4}	P^c_t	P^c_{t-1}	MH_{t-1}	FH_{t-1}	TH_{t-1}	Number of Observations	$\bar{R}^2$	ρ	Durbin-Watson Statistic
1. MS	−0.8177 (0.645)	−0.2732 (0.083)	...	...	...	...	1.1088 (0.078)	...	...	30	0.973	0.554 (0.15)	1.89
2. MS	−1.345 (0.82)	−0.2935 (0.097)	...	...	...	...	1.1837 (0.090)	...	...	25	0.963	0.4700 (0.17)	1.89
3. MS	0.395 (1.31)	−0.2915 (0.095)	...	...	−0.1902 (0.088)	1.1299	... (0.121)	...	...	24	0.960	0.5740 (0.16)	1.81
4. MS	−1.7849 (1.34)	−0.3244 (0.102)	...	...	...	0.1508 (0.113)	1.1393 (0.118)	...	...	24	0.960	0.5700 (0.16)	1.81
5. MS	−3.398 (0.861)	...	0.3311 (0.109)	...	...	...	0.9719 (0.10)	...	...	22	0.945	0.3300 (0.20)	1.72
6. MS	−3.17 (1.09)	...	...	0.2877 (0.102)	...	...	0.9779 (0.126)			22	0.959	0.4800 (0.18)	1.35
7. FS	0.6127 (2.04)	−0.8941 (0.245)	...	...	...	...	...	1.2667 (0.265)	...	30	0.75	0.51 (0.15)	1.69
8. FS	−0.999 (2.56)	−1.1634 (0.279)	...	...	...	...	...	1.6267 (0.318)	...	25	0.75	0.43 (0.18)	1.81
9. FS	−0.6533 (3.57)	−1.1396 (0.307)	...	...	−0.094 (0.27)	...	...	1.6423 (0.35)	...	24	0.73	0.44 (0.17)	1.75
10. FS	−0.9015 (3.57)	−1.1473 (0.307)	...	...	...	−0.0611 (0.321)	...	1.6513 (0.352)	...	24	0.73	0.42 (0.18)	1.75
11. FS	−9.337 (2.34)	...	1.1484 (0.240)	...	...	...	...	0.9623 (0.253)	...	22	0.73	0.16 (0.21)	1.75
12. FS	−7.69 (2.07)	...	...	1.044 (0.249)	...	...	...	0.8548 (0.252)	...	22	0.71	−0.02 (0.21)	1.79
13. TS	−1.945 (2.01)	−0.6442 (0.141)	...	...	...	...	...	...	1.4064 (0.22)	25	0.92	0.62 (0.15)	1.73
14. TS	−6.5286 (1.56)	...	0.6942 (0.148)	...	...	...	...	...	1.016 (0.162)	22	0.90	0.32 (0.20)	1.67

Notes: The numbers in parentheses are standard errors. P is price, MH is male herd, FH is female herd, TH is total herd, MS is sales of male cattle, FS is sales of female cattle, and TS is total sales.

explanatory variable. The coefficients for the own price and herd variables have the expected signs and are highly significant, and the estimated short-run elasticity for female sales is higher than for male sales. However, the estimated coefficients for the prices of crops are not significant.

When the expansion of crop and beef output comes through an expansion in cultivated area, it is possible that crop prices do not have a strong influence on beef production. This seems to have been the case in Colombia.[43] Moreover, since the estimated price coefficient for sales has a negative sign, this might indicate that in the short run an increase in prices leads to a retention (withholding) of animals from sales, thus supporting the idea that during the period under consideration land was not a limiting factor.[44]

Regression equations (5), (6), (11), and (14) show the response of male and female sales to changes in prices three and four years back. The results show a positive price elasticity and indicate that after some time has elapsed prices and sales are positively associated. This finding suggests that present sales are the result of price changes in several periods rather than in one, thereby indicating that the estimation of the sales equation should incorporate several past price changes.

Since the economic horizon of cattle growing is longer than one year, it is reasonable to incorporate explicitly the effect of past prices on the present level of sales. Past prices affect the desired stock of animals, and changes in the stock will come through changes in sales and births. For example, an increase in the price of beef increases the stock of animals desired. To reach this desired position, sales have to fall or births have to increase, so that the actual and desired additions to the stock are equal until long-run equilibrium is achieved.

To estimate the supply response of male and female sales in the short and long runs, past price changes are incorporated using the polynomial distributed lag model. To estimate the distributed lag equation, a third-degree polynomial with lags of six and eight periods for the price variable is used. The general form of the model is

$$\ln MS_t = C + \sum_{i=0}^{J} \alpha_i \ln P_{t-i} + \beta_M \ln MH_{t-1}, \tag{35}$$

$$\ln FS_t = C + \sum_{i=0}^{J} \gamma_i \ln P_{t-i} + \gamma_H \ln FH_{t-1}, \text{ and} \tag{36}$$

$$\ln TS_t = C + \sum_{i=0}^{J} \lambda_i \ln P_{t-i} + \lambda_H \ln MH_{t-1}, \tag{37}$$

where $J = 6, 8$, and C is a constant. The αi and γi coefficients measure the effect of a change in price in period $t - i$ on male and female sales in period t, and the β_M and γ_H coefficients measure the influence of the male herd on male slaughter and the female herd on female slaughter in period t. The equations are estimated using ordinary least squares and unrestricted coefficients. The results are reported in Table 21.[45] Statistically the results are good and conform to the hypothesis about expected signs and values for the estimated coefficients.

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[43] See Ramiro Orozco, *Sources of Agricultural Production and Productivity in Colombian Agriculture* (Ph.D. dissertation, Oklahoma State University, 1977).

[44] These arguments should not be interpreted as saying that crop prices are not important. In fact, in the long run changes in crop prices will affect the size and location of this activity. Thus, the Eastern Plains region, where land is more abundant, has gained in importance as a beef producer.

An increase in the contemporaneous price of beef strongly reduces the sale of females, while it has a negligible effect on the sale of males. Moreover, total sales fall when the contemporaneous price of cattle rises. These results support the hypothesis that the price elasticity of female sales is higher (in absolute value) than the price elasticity of males. The strongest effect on male and female sales of a price change is felt three years after the change takes place. The effect of a price change extends to six years for females and five years for males. Moreover, the average time (estimated mean lag) that it takes for a price change to work out its effects on sales is around 3.0 years for males and between 4.5 and 5.5 years for females as evidenced by the size of the estimated mean lag. For total sales the estimated mean lag fluctuates between 3.4 and 3.9 years.

The "long-run" supply elasticity of male and female sales is the sum of all the estimated price coefficients. According to these estimates, the supply elasticity of female sales is large and higher than that for male sales, and the estimated long-run elasticity of supply of total sales varies between 1.38 and 1.45. In summary, these estimates strongly support the hypothesis that cattle sales respond positively to price changes in the long run, despite negative short-run responses.

Supply Response of Aggregate Agricultural Output

The issue of aggregate supply response in Colombian agriculture has not been dealt with in Colombian literature, except for efforts by García to estimate the supply response of food for the period 1950-76.[46] A very simple framework is used here to estimate the aggregate supply response of agriculture in Colombia for the period 1950-80.

Aggregate supply response in agriculture is a complex subject, and to deal adequately with it requires a considerable amount of information and modeling.[47] Thus, one would like to capture all the interactions between product and factor markets as well as the role of technical change in that response. Changes in relative output prices trigger changes in factor prices, as well as movement of factors within agriculture and between agriculture and the rest of the economy. Capital accumulation depends on expected returns to capital, which in turn depend on relative prices. In addition, the adoption of new technologies is also a function, among other things, of relative prices and the rate of capital accumulation.[48] To model this type of interaction between product and factor markets is not possible at the present stage, because the information available

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[45] Equations (35), (36), and (37) were also estimated with ordinary least squares and far-end constraints on the coefficients, and the results were similar to the ones presented here.

[46] See Jorge García García, *The Effects of Exchange Rate and Commercial Policies on Agricultural Incentives in Colombia: 1953-1978,* Research Report 24 (Washington, D.C.: International Food Policy Research Institute, 1981), Appendix 2.

[47] For a recent survey of the issue of aggregate supply response in agriculture and the problems involved in analyzing agricultural supply in a general equilibrium comparative dynamics framework, see Yair Mundlak, *The Aggregate Agricultural Supply,* Working Paper No. 8511 (Rehovot, Israel: Center for Agricultural Economic Research, 1985). An analysis of these interrelations for Argentina is found in Cavallo and Mundlak, *Agriculture and Economic Growth in an Open Economy: The Case of Argentina.*

[48] See Mundlak, *Aggregate Agricultural Supply,* pp. 44-58; and Yair Mundlak, *Capital Accumulation, the Choice of Technique and Agricultural Output,* Working Paper No. 8504 (Rehovot, Israel: Center for Agricultural Economic Research, October 1984).

Table 21—Short- and long-run responses of male, female, and total cattle sales, estimated using polynomial distributed lags, 1954-75

	Regression and Dependent Variable					
Coefficient	**(1) MS**	**(2) MS**	**(3) FS**	**(4) FS**	**(5) TS**	**(6) TS**
Constant	−2.805 (1.41)	−2.9374 (1.29)	−9.7687 (2.19)	−9.957 (2.76)	−7.578 (1.20)	−7.8449 (1.22)
P_t	−0.0555 (0.11)	−0.0355 (0.07)	−0.5764 (0.32)	−0.52 (0.22)	−0.2002 (0.17)	−0.2031 (0.11)
P_{t-1}	0.0623 (0.06)	0.0783 (0.07)	0.4601 (0.09)	0.459 (0.14)	0.1329 (0.07)	0.1711 (0.09)
P_{t-2}	0.1255 (0.06)	0.1398 (0.07)	0.4601 (0.09)	0.459 (0.14)	0.328 (0.06)	0.3671 (0.07)
P_{t-3}	0.1464 (0.07)	0.1587 (0.06)	0.5564 (0.08)	0.5816 (0.11)	0.4047 (0.06)	0.4223 (0.06)
P_{t-4}	0.1371 (0.07)	0.1449 (0.05)	0.5153 (0.12)	0.5408 (0.08)	0.3829 (0.07)	0.3741 (0.05)
P_{t-5}	0.1101 (0.05)	0.1083 (0.04)	0.395 (0.10)	0.3972 (0.09)	0.2822 (0.06)	0.2598 (0.05)
P_{t-6}	0.0774 (0.07)	0.0586 (0.03)	0.2934 (0.28)	0.2116 (0.12)	0.1225 (0.14)	0.1167 (0.06)
P_{t-7}	...	0.0057 (0.03)	...	0.0449 (0.15)	...	−0.0177 (0.07)
P_{t-8}	...	−0.0404 (0.05)	...	−0.0422 (0.21)	...	−0.1064 (0.10)
$FH4_{t-1}$	...	...	0.6336 (0.28)	0.6387 (0.32)	...	...
$MH3_{t-1}$	0.7709 (0.12)	0.7753 (0.11)	...	...	...	...
TH_{t-1}	...	...	...	...	0.6361 (0.18)	0.7074 (1.22)
Sum of price coefficients	0.6033 (0.37)	0.6183 (0.34)	1.7622 (0.48)	0.7848 (0.46)	1.4531 (0.40)	1.3839 (0.37)
R^2	0.98	0.98	0.87	0.84	0.95	0.95
Mean lag	3.8388 (0.82)	3.2721 (1.17)	4.8371 (0.95)	4.5775 (1.65)	3.9095 (0.67)	3.3908 (1.08)
Durbin-Watson statistic	1.41	1.47	1.92	1.90	1.57	1.69
Number of observations	22	22	22	22	22	22

Notes: The variables are expressed in logarithms. The numbers in parentheses are standard errors. P_{t-i} is price lagged by i years. FH is female herd, MH is male herd, and TH is total herd. MS is male sales, FS is female sales, and TS is total sales. Ordinary least squares and unrestricted coefficients are used to estimate the equations.

is inadequate and because it is beyond the scope of this report. Therefore, the results reported here using a simpler framework can only be considered preliminary.

Factors other than price of output have been incorporated as explanatory variables of agricultural supply.[49] The attempt at estimating supply response in Colombian agriculture in this section is done in terms of gross value of output and real value added. The estimating period covers the years 1950-80, using data from the national accounts of Banco de la República.[50]

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[49] Information to incorporate these other factors is taken from Víctor Elías, *Government Expenditures on Agriculture and Agricultural Growth in Latin America,* Research Report 50 (Washington, D.C.: International Food Policy Research Institute, 1985).

The estimating equation takes the following general form:

$$\ln O = c + \alpha \ln P + \beta \ln K + \sigma \ln F + \delta \ln T + \gamma \ln L + \theta PCI + \mu PI + u, \qquad (38)$$

where

ln = natural logarithm of the variable,
O = real gross output or real value added (in 1975 pesos),
P = price of agriculture (gross output or value added) relative to price of nonagriculture (value added),
K = real physical capital stock in agriculture (in 1958 pesos),
F = index of fertilizer use,
T = harvested land,
L = labor employed in agriculture,
PCI = per capita income or comprehensive capital, and
PI = public input (in 1960 pesos).

A variable that should have been included but is not, due to lack of information, is the price of agricultural inputs. The data for all the variables in equation (38) except output, per capita income, prices, and labor are taken from a study by Victor Elías.[51]

Initially, the variables listed in equation (38) were used simultaneously. The public input variable was not significant and the coefficient for harvested land was negative but not significant. The negative sign for the land coefficient is probably the result of having an inadequate measure of this variable. Harvested land only refers to land used in crops, thereby omitting land used in livestock production, an activity that composes one-third of agricultural output. The capital stock in livestock was tried as another explanatory variable, but its significance varied greatly between regressions, and for this reason it was left out.[52]

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[50] Another set of statistics on agricultural output, beginning with 1965, is available from DANE, but this set is not used because it is not totally compatible with that from Banco de la República, *Cuentas Nacionales*.

[51] Elías' information is used as it is presented; no attempt is made to convert his series to 1975 prices, since neither the deflators nor the nominal values for the series are reported. The difference in the value of the deflators would be reflected in the value of the constant (Elías, *Government Expenditures on Agriculture*).

Information on herd size is taken from a study by Rivas, but his estimates may present problems due to the treatment given to illegal export or slaughter (extraction). Rivas assumes that illegal or nonregistered extraction is a constant 10 percent of legal extraction. This is not correct because an important component of illegal extraction is smuggled to Venezuela and therefore depends on price differentials between the two countries. Differentials have not remained constant over time. See Libardo Rivas, "Evolución del Inventario Vacuno de Colombia y su Interacción con los Precios 1951-1980," *Revista de Planeación y Desarrollo* 14 (September-December 1982): 162-184.

The variables that produce consistent results over the various regressions are prices, capital stock, fertilizer, employment, and GDP per capita, the latter taken as a measure of comprehensive capital.[53] Fertilizer is taken as an explanatory variable because it may have been an important constraint in the growth of agricultural output, considering that this input was not readily available to farmers in the desired quantities and qualities due to import restrictions. This variable turns out to be highly significant in explaining supply response. Both fertilizer and capital accumulation capture part of the effect of changes in agricultural prices, because an increase or decrease in those prices tends to make the use of fertilizer or the return to capital more or less profitable. This may bias the estimated coefficient for agricultural prices downward.

The results from estimation of the aggregate supply response are presented in Table 22. When the estimated price coefficient is lagged two periods, it varies between 0.10 and 0.20 when real value added is the dependent variable, and it rises to 0.25 when real gross value of output is the dependent one. According to these results the response of agricultural output to changes in prices is not high and takes more than one period to occur. It should be kept in mind when interpreting these results that two-thirds of agricultural output (one-third each) is generated by livestock and coffee, which take more than one year to respond to changes in prices compared with annual crops. In addition, because a full interrelationship between factors and product markets is not considered here, the estimates presented are short-run price elasticities, rather than medium- or long-run ones. To correctly evaluate the role of price, the response of the various inputs to price variations should also be evaluated. This, however, could not be done because information on input prices is not available.

One final note on this issue of aggregate supply response. An attempt to estimate the supply response of agricultural output was done using the partial adjustment model utilized in the estimation of the individual commodities. This effort was only successful for the estimation of the supply of food and then only where the price of food was divided by the implicit GDP deflator. The results of this attempt are also reported in Table 22. The estimated short-term elasticity of supply of food is 0.4, but the long-term elasticity of food supply cannot be calculated, as the coefficient for lagged food output is larger than one.

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[53] See H. Binswanger, et al., *Estimation of Aggregate Agricultural Supply Response,* ARU Report No. 48, Agricultural and Rural Development Department (Washington, D.C.: World Bank, 1985), pp. 28-29.

Table 22—Estimation of aggregate supply response in agriculture

Dependent Variable/ Period	Constant	Price of Food T−1	Price of Agriculture T−2	Capital Stock T−1	Fertilizer T−1	Employment T	Per Capita GDP Index T	Food T−1	Adjusted R^2	Autocorrelation	Durbin-Watson Statistic
Real value added 1953-80	−2.66483[a] (−17.00)	. . .	0.13412[b] (2.2337)	0.71852[a] (34.624)	0.14186[a] (15.424)	. . .	. . .	. . .	0.9949	−0.13266 (−0.6223)	2.0064
Real value added 1953-80	−11.20722[a] (−3.927)	. . .	0.11134[b] (1.9954)	0.5814[a] (11.378)	0.05858[b] (2.0629)	. . .	. . .	. . .	0.9963	. . .	1.7616
Real value added 1953-80	−2.38859[a] (−12.40)	. . .	0.17087[a] (2.6331)	0.36321[a] (2.6704)	0.12651[a] (11.552)	. . .	0.65073[a] (2.7020)	. . .	0.9959	0.09284 (0.4306)	. . .
Real value added 1952-80	−9.24207[a] (−3.372)	. . .	0.12582[b] (2.4573)	0.42245[a] (4.4610)	0.06587[a] (2.4918)	1.01633[a] (2.4808)	0.34623[b] (1.9242)	. . .	0.9969	. . .	1.6840
Real value added 1952-80	−2.4533 (−15.1826)	. . .	0.1541[a] (2.8013)	0.4495 (4.3363)	0.1276[a] (13.0699)	. . .	0.4961[a] (2.6564)	. . .	0.9962	. . .	1.9214
Real gross output 1952-80	−4.1219[a] (−9.362)	. . .	0.22979[a] (3.2632)	0.76826[a] (30.224)	0.15103[a] (15.625)	. . .	. . .	. . .	0.9949	. . .	1.9094
Real gross output 1952-80	−9.9729[a] (−3.077)	. . .	0.2136[a] (3.1432)	0.6615[a] (11.3540)	0.0931[a] (2.8100)	0.896[c] (1.8206)	. . .	. . .	0.9953	. . .	1.7825
Real gross output of food 1951-80	−2.2324[a] (−2.737)	0.41297[a] (2.5979)	. . .	. . .	. . .	. . .	. . .	1.03453[a] (56.8365)	0.9918	. . .	2.1659

Notes: Where real value added is the dependent variable, the relative price is the price of value added in agriculture over the price of value added in nonagriculture. Where real gross value of output is the dependent variable, the relative price for regressions is the price of gross value of output over the price of value added in nonagriculture. Where real gross value of food output is the dependent variable, the relative price is the price of the gross value of food output over the GDP deflator.

[a] Significant at 99 percent.

[b] Significant at 97 percent.

[c] Significant at 95 percent.

6

INCOME DISTRIBUTION AND REAL WAGES IN AGRICULTURE

The issue of income distribution is a topic that has attracted substantial attention among students of Colombian economic development. Research on this topic has concentrated on the personal and regional inequality of income, both urban and rural, and in the country as a whole.[54]

This chapter breaks with that tradition in the sense that it examines, first, the effects of changes in the price of coffee on the functional distribution of income between labor and nonlabor factors of production in different sectors of the economy (coffee, noncoffee tradables, and nontradables), and, second, the factors that affect real wages in the agricultural sector. The framework used for the analysis of the effect of terms-of-trade changes on the functional distribution of income is the one developed by Corden and Neary.[55] For the convenience of the reader, points in that paper relevant for the analysis here are summarized in the first part of this chapter. The factors that determine behavior of real wages in agriculture are examined with the help of a simple framework of supply and demand for labor, which incorporates elements of the Todaro model.[56] The main implications from each model are tested using data for 1970-82 for the effect of terms-of-trade changes on the functional distribution of income and 1967-83 for the determinants of rural wages.

Functional Distribution of Income

Theoretical Framework

The framework adopted is the same one used in Chapter 4, that is, a small, open economy, which produces two traded goods, coffee and noncoffee, at exogenously given world prices, and one nontraded good. Prices are assumed to be flexible to restore equilibrium in supply and demand in the nontraded goods market, and income is assumed to equal expenditure, thereby satisfying the basic conditions for general equilibrium in the system. The framework presented in this section summarizes briefly the relevant points of the Corden and Neary paper, which is concerned with the issue of the functional distribution of income.

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[54] See especially R. Albert Berry and Miguel Urrutia, *Income Distribution in Colombia* (New Haven, Conn.: Yale University Press, 1976); R. Albert Berry, "Land Distribution, Income Distribution and the Productive Efficiency of Colombian Agriculture," *Food Research Institute Studies in Agricultural Economics, Trade and Development* 12 (No. 3, 1973); Rafael Prieto, *Estructura del Gasto y Distribución del Ingreso Familiar en Cuatro Ciudades Colombianas: 1967-1968* (Bogotá: Centro de Estudios sobre Desarrollo Económico, Universidad de los Andes, 1971); Gary S. Fields and T. Paul Schultz, "Regional Inequality and other Sources of Income Variation in Colombia," *Economic Development and Cultural Change* (April 1980): 447-467; and Miguel Urrutia, *Winners and Losers in Colombia's Economic Growth of the 1970s* (Oxford: Oxford University Press, 1985).

[55] Corden and Neary, "Booming Sector and Deindustrialization." The authors have also benefited from a paper by Harold E. Banguero, "Evaluating the Impact of a Coffee Boom on Income Distribution: An Examination with Colombian Data," 1986 (mimeographed).

[56] Michael P. Todaro, "A Model of Labor Migration and Urban Unemployment in the Less Developed Countries," *American Economic Review* 60 (March 1969); and John R. Harris and Michael Todaro, "Migration, Unemployment, and Development: A Two Sector Analysis," *American Economic Review* (March 1970): 126-142.

Because a large share of agricultural output is tradable, one of the main concerns of the analysis is to establish what happens to the profitability and income of factors of production in the noncoffee tradables sector when there is a large change in the price of coffee.

The analysis proceeds by considering different degrees of intersectoral factor mobility. To facilitate the discussion, the analysis starts with a case in which only one factor (labor) is mobile between sectors and the others are sector-specific.[57] The analysis is later expanded to a situation in which more than one factor is mobile. The actual extent of factor mobility is not known in advance, and it can only be presumed from the empirical results presented in the second section of this chapter.

Following Corden and Neary, a distinction is made between the resource movement effect and the spending effect of the boom on income distribution. The resource movement effect occurs when the boom raises the marginal products of the mobile factors in the coffee sector and draws resources out of other sectors, inducing the rest of the economy to make adjustments. One of these adjustments is the appreciation of the real exchange rate, that is, a rise in the relative price of nontraded to traded goods. The spending effect results from a higher real income generated by the boom, which leads to additional spending on nontraded goods, which in turn raises their prices (a real appreciation), leading to further adjustments in the economy. If only one factor is mobile between sectors, the resource movement and spending effects lead to a reduction in the relative size of the sector producing noncoffee tradables.

The results on income distribution depend on several important assumptions. The first has to do with the mobility or specificity of resources between coffee and other sectors of the economy. In the short run, there is likely to be some movement of labor from one sector to another, but capital (land, investment in coffee trees, physical capital, and so forth) is only mobile in the medium and long runs.[58] The second assumption deals with the distribution of coffee earnings and the marginal propensities to consume nontraded goods. The final important element is the assumption of capital-intensity for the different sectors. An analysis of the two cases relevant to the discussion of the effects of terms-of-trade changes on the functional distribution of income is presented in the next two sections.

Effects of a Coffee Boom When Only Labor Is Mobile

The effects of a boom on labor and commodity markets are analyzed with the help of Figures 4 and 5. The price of the noncoffee tradable commodity is selected as the numeraire. The wage rate expressed in terms of noncoffee tradables is measured on the vertical axis of Figure 4, while total labor supply is measured by $O_N O_T$ on the horizontal axis. Labor input into nontraded commodities (N) is measured by the distance from O_N, while distances from O_T measure labor input into traded commodities (T), such as coffee and other tradables. The demand for labor is assumed to be a decreasing

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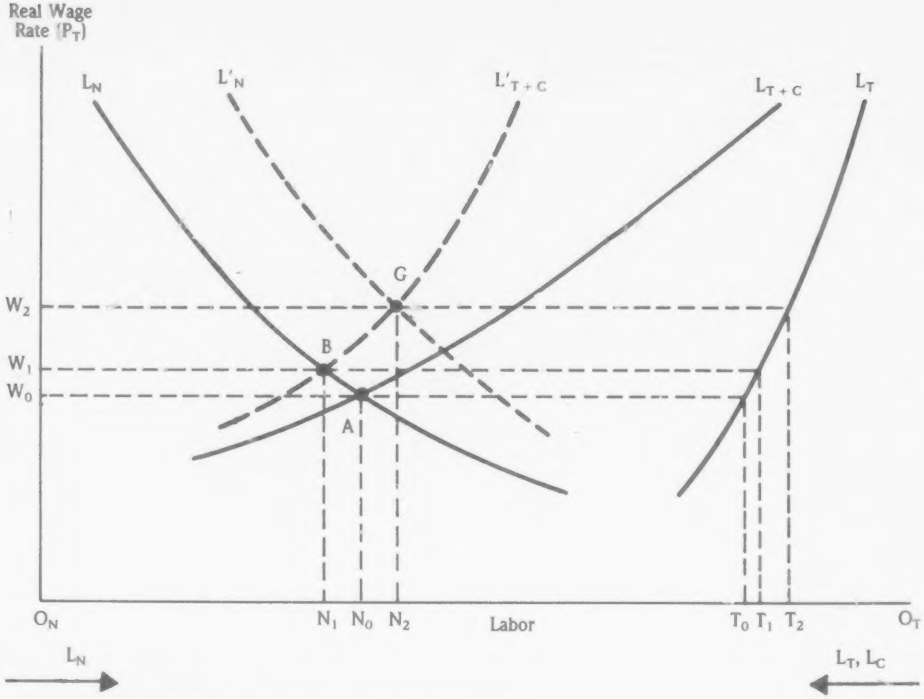
[57] For this kind of model, see R. W. Jones, "A Three Factor Model in Theory, Trade and History," in *Trade, Balance of Payments and Growth: Essays in Honor of C. P. Kindleberger,* ed. J. N. Bhagwati et al. (Amsterdam: North Holland, 1971); R. H. Snape, "Effects of Mineral Development on the Economy," *Australian Journal of Agricultural Economics* 21 (December 1977): 147-156; and Corden and Neary, "Booming Sector and Deindustrialization."

[58] The empirical results presented in this report strongly support this assumption.

Figure 4—Effect of a coffee boom on the labor market



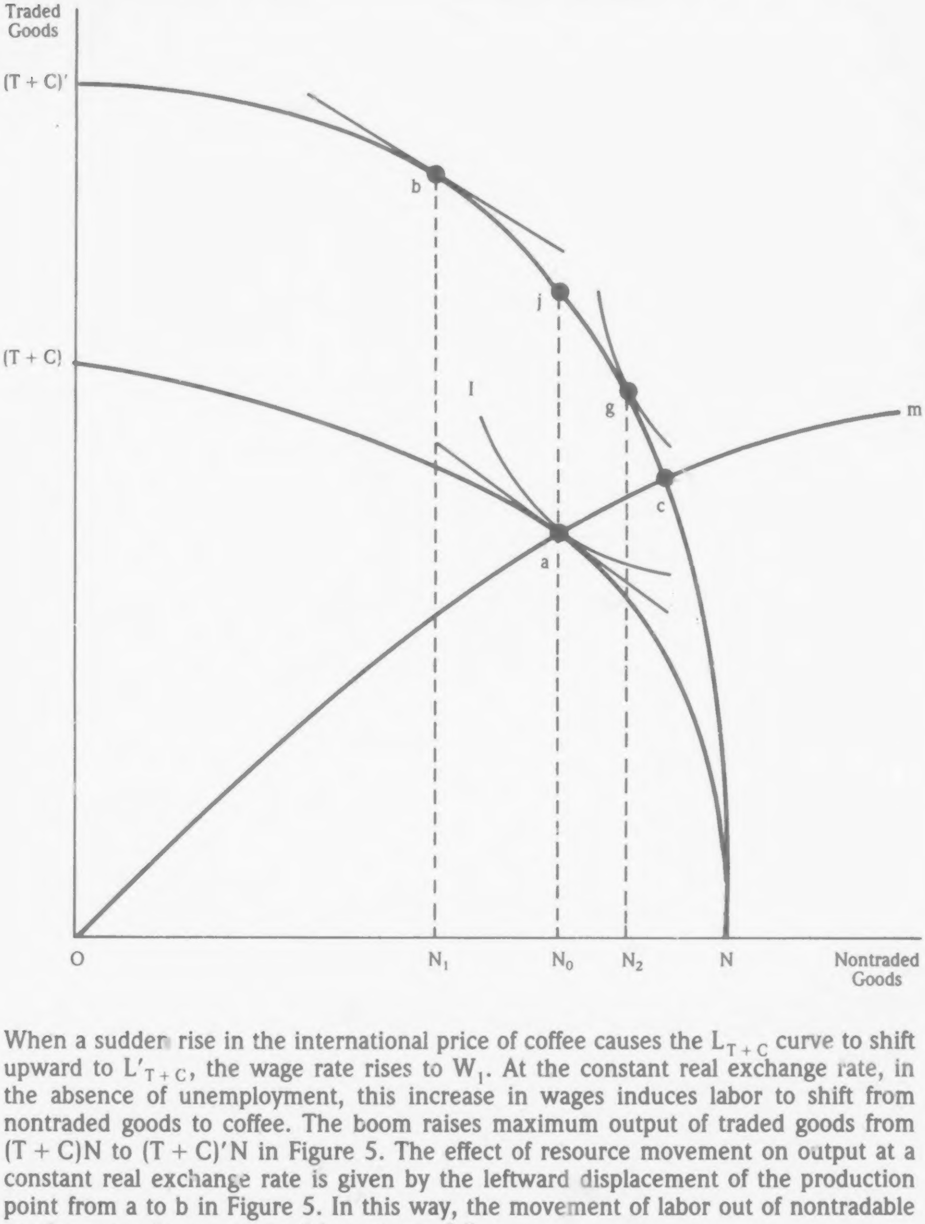
Notes: O_N = Total labor supply used in the nontraded goods sector.
O_T = Total labor supply used in the traded goods sector.

function of the wage rate relative to the price of each sector's output. Therefore, L_T is the labor demand schedule for noncoffee tradables, and by adding the demand for labor for coffee to it, the demand for labor for tradables is obtained. It is shown as L_{T+C} in Figure 4. Similarly, L_N is the nontraded sector's initial labor demand. Initial equilibrium in the labor market is at A, where L_N intersects L_{T+C}; therefore, the initial wage rate is W_0.

It is necessary, however, to determine the initial price of nontraded commodities to complete the general equilibrium model because the location of the L_N schedule depends on this price. Figure 5 shows how it is determined. Traded goods—coffee plus other tradables—are plotted on the vertical axis and nontraded goods on the horizontal one. The initial production possibility curve is given by (T + C)N, and initial equilibrium is at point a, when the production possibility curve is tangent to the indifference curve I. The initial price of nontraded goods or the initial exchange rate for traded goods is thus given by the slope of the common tangent at point a.

Continuing the distinction made before, the resource movement and the spending effects of the boom are looked at separately. In the case of resource movements a two-stage analysis is conducted. First, the real exchange rate (relative price of nontradables) is held constant; then it is allowed to change to restore equilibrium. Therefore, in the first stage the L_N curve in Figure 4 and the price ratio in Figure 5 are unchanged.

Figure 5—Effect of a coffee boom on the commodity market



When a sudden rise in the international price of coffee causes the L_{T+C} curve to shift upward to L'_{T+C}, the wage rate rises to W_1. At the constant real exchange rate, in the absence of unemployment, this increase in wages induces labor to shift from nontraded goods to coffee. The boom raises maximum output of traded goods from (T + C)N to (T + C)'N in Figure 5. The effect of resource movement on output at a constant real exchange rate is given by the leftward displacement of the production point from a to b in Figure 5. In this way, the movement of labor out of nontradable goods causes the output in this sector to fall.

Assuming, for the moment, that the income elasticity of demand for nontraded goods is zero, the resource movement effect at the initial real exchange rate leads to excess demand for nontraded goods, which means that there must be a real appreciation of the exchange rate in order to restore equilibrium, with equilibrium taking place at some point between b and j on the (T + C)'N curve.

In order to analyze the spending effect, the resource movement effect is controlled by assuming that the coffee sector does not use any labor. Therefore, at the initial real exchange rate the boom has no effect on labor demand curves L_N and L_{T+C} in Figure 4. However, the boom shifts the production possibility curve vertically upwards, point b now lying above point a in Figure 5. If the demand for nontraded goods rises with income, the demand at the initial exchange rate moves along an income-consumption curve represented by Om in Figure 5, intersecting the production possibility curve (T + C)'N at point c. Again, there is an excess demand for nontraded goods at the original real exchange rate, indicating that a real appreciation must occur, but this time output of nontraded goods rises because the new equilibrium must be somewhere between j and c.

When the resource movement and the spending effect are combined, it can be seen that both contribute to a real appreciation of the real exchange rate. However, the resource movement effect tends to lower output of nontraded goods, whereas the spending effect tends to raise it. Figure 5 represents the case where the spending effect is stronger, so point g lies to the right of point j. This ambiguity does not occur with output of noncoffee tradables.

Returning to Figure 4, the curve representing the demand for labor for the nontraded sector shifts upward to L'N because of the increase in the price of nontraded goods, and the final equilibrium is reached at point G. As a result, the wage rate rises to W_2, and employment in the noncoffee tradable sector falls from O_TT_1 to O_TT_2. Thus, because of the movement of resources the coffee boom brings about a direct reduction in output in noncoffee tradables, which is reflected in the distance T_0T_1 in Figure 4. The spending effect also leads to an indirect reduction in output of the same sector, given by the distance T_1T_2.

With regard to the wage rate, the resource movement effect leads to a fall in the output of nontraded goods, which is associated with an increase in the wage rate for nontraded goods. Since, for tradables, the wage rate must rise as a result of the resource movement effect, the real wage rate must also rise because of it. On the other hand, the spending effect leads to a rise in both the output and price of nontraded goods and to a fall in the wage rate for nontraded goods. Since the wage rate for traded goods rises because of the spending effect, through the mechanism of real appreciation, the real wage may rise or fall.

Changes in returns to specific factors of production in the three sectors can be measured as the effect of the boom on profitability. It is clear that profitability in noncoffee tradables must fall. Profitability in the nontraded sector would rise if only the spending effect were considered, but the resource movement could cause it to fall. If the output of nontraded goods rises, profitability in this sector must rise for all goods. Finally, profitability in the coffee sector would rise because of the resource movement effect, but it would fall because of the spending effect. A factor specific to the coffee sector does not benefit from the spending effect because the world price of coffee is fixed, and the benefits of the boom could spread to other factors to such an extent that a specific factor could actually lose.

Although it is clear that the returns to a specific factor in noncoffee tradables fall in absolute terms, it is not necessarily so when profitability is measured in relative terms. In fact, if the share of capital in value added in the noncoffee tradables sector is smaller than in other sectors, then a rise in the wage rate reduces its profitability less than the reduction in other sectors. Therefore, a decline in relative profitability of noncoffee tradables is less likely to occur if this sector is capital-intensive, so that it is less vulnerable than other sectors to the squeeze on profits induced by the increase in wages. Because relative profitability is the force driving resource allocation in the medium run, the boom might in this case increase the output of noncoffee tradables if capital is mobile between sectors.

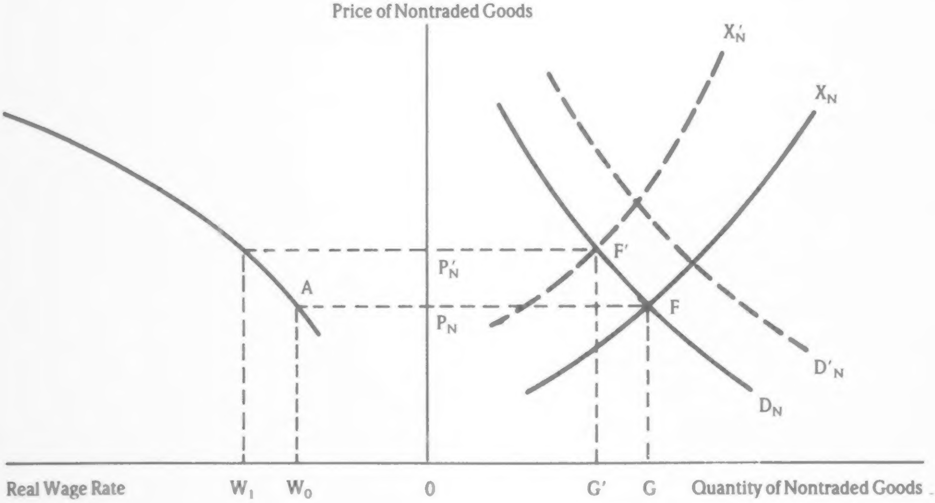
Effects of a Coffee Boom When Capital Is Mobile Between Two Sectors

In the previous case it was assumed that only labor was allowed to move between sectors. In this case capital can be transferred between the noncoffee tradables and the nontraded sectors, but it is sector-specific in the case of coffee. It is helpful for this analysis to view the noncoffee tradable and nontraded sectors as a Heckscher-Ohlin model, where a variable supply of labor is equal to the total amount of labor in the economy less the amount employed in the coffee sector. Here there is an unusual relationship between the equilibrium wage rate and the price of nontraded goods, both measured in terms of tradable goods. This relationship is shown in the left-hand side of Figure 6, with an upward-sloping curve reflecting the capital intensity of noncoffee tradables relative to nontraded goods.

Supply and demand curves for nontraded goods are drawn in the right-hand side of Figure 6. The supply curve X_N is upward-sloping, reflecting the normal supply response of the economy. The demand curve D_N is drawn on the assumption that expenditure is equal to income. Equilibrium before the boom is represented by points A and F.

As before, the resource movement effect of the boom is considered separately by assuming zero income elasticity of demand for nontraded goods, so that the demand curve D_N in Figure 6 does not shift. At the initial wage rate, the boom raises the demand for labor of the coffee sector and reduces the amount used in the two sectors

Figure 6—Effects of a coffee boom when capital moves between noncoffee tradable and nontradable sectors



with mobile capital. Following Rybczynsky's theorem, at constant prices the output of the labor-intensive good falls, as reflected in the shift of the supply curve for nontraded goods in Figure 6 from X_N to X'_N, and the displacement of the equilibrium point from F to F'. Output falls from OG to OG', wages rise from W_0 to W_1, and prices of nontraded goods increase from P_N to P'_N. Thus, in this model a fall in output of nontraded goods must be associated with an increase in output of noncoffee tradables.[59]

The spending effect of the boom induces an outward shift of the demand curve D_N to D'_N, raising output and the price of nontradables while reducing the output of noncoffee tradables. However, the higher price of nontraded goods is only associated with a higher wage rate if the nontradables are relatively labor-intensive as in Figure 6.

In short, if the noncoffee tradables are capital-intensive in relation to nontraded goods, the relative price of nontraded goods will increase, the real wage rate will go up, and the absolute profitability in the two sectors will go down as a result of the coffee boom. The effects of an increase in public expenditure can also be analyzed in this context and will have the same consequences as the spending effect described before.

Empirical Results

The main purpose of this section is to determine empirically the effects of changes in the price of coffee on the income from capital. In this context, capital income should be interpreted as the income from capital and other nonlabor factors of production. Thus, capital income should be understood more broadly as nonlabor income. Similarly, capital intensity should be understood as intensity in nonlabor factors of production. For the rest of this chapter, unless otherwise specified, the terms income from capital and nonlabor income will be used interchangeably.

According to the results presented in the previous section, when the noncoffee tradable sector is more capital-intensive than the nontraded sector, an increase in the price of coffee will increase the relative price of nontraded goods and real wages and decrease the *absolute values* of the capital returns in the nontraded and noncoffee tradable sectors. The information presented in Table 23, processed from national accounts data, shows the share of labor in value added in each of the three categories of coffee, nontradables, and noncoffee tradables. This information tends to support the idea that noncoffee tradables are more capital intensive than nontradables. From the analysis of the previous section and the degree of factor intensity shown in Table 23, it would appear, then, that an increase in the price of coffee would increase the price of nontraded goods and reduce the absolute value of the return to nonlabor income in the nontraded and noncoffee tradable sectors. In other words, the effects of an increase in coffee prices on nonlabor income will be negative in both sectors. The regression models used to estimate the impact of changes in relative prices on absolute real nonlabor income try to do this by relating nonlabor income in each sector to the price of coffee and the real value added of the sector. The estimating equations are as follows:

$$NLY_N = \alpha_0 + a_1 LP_C + \alpha_2 LP_N + \alpha_3 LKVA_N, \qquad (39)$$

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[59] If the noncoffee tradables sector is labor-intensive relative to nontradables, the wage rate rises, output of nontraded goods rises, the price of nontraded goods falls, and output of noncoffee tradables also falls.

Table 23—Share of labor income in value added

Year	Importables	Exportables			Noncoffee Tradables	Nontradables	Total
		Coffee	Noncoffee	Total			
				(percent)			
1970	38.8	19.4	35.4	32.4	36.5	42.3	38.7
1971	39.5	18.8	35.6	33.0	36.9	42.6	39.2
1972	38.0	18.4	34.9	32.2	35.9	43.0	38.8
1973	36.3	15.9	33.6	30.4	34.4	42.3	37.5
1974	32.3	18.0	32.9	30.7	32.7	42.2	37.1
1975	35.5	15.4	34.6	31.2	34.9	42.3	37.8
1976	35.5	14.4	35.7	30.9	35.6	41.9	37.3
1977	35.5	17.4	36.9	31.4	36.4	41.7	37.4
1978	38.0	22.9	40.9	36.4	39.8	42.7	40.1
1979	39.4	27.4	41.6	38.5	40.8	43.4	41.4
1980	42.9	25.5	40.1	37.2	41.0	45.4	42.5
1981	43.7	37.3	41.0	40.4	41.8	45.3	43.7
1982	44.6	32.8	40.7	39.6	42.1	45.8	43.9

Source: Derived from Colombia, Departamento Administrativo Nacional de Estadística (DANE), *Cuentas Nacionales de Colombia; 1970-1983* (Bogotá: DANE, 1984); and working sheets for 1970-83 provided by DANE, División de Cuentas Nacionales.

Note: Appendix 1 explains the derivation of these data.

$$NLY_C = \beta_0 + \beta_1 LP_C + \beta_2 LP_N + \beta_3 LKVA_C, \qquad (40)$$

and

$$NLY_T = \gamma_0 + \gamma_1 LP_C + \gamma_2 LP_N + \gamma_3 LKVA_T, \qquad (41)$$

where

NLY_N = logarithm of real nonlabor income in the nontraded sector,

NLY_C = logarithm of real nonlabor income in the coffee sector,

NLY_T = logarithm of real nonlabor income in the noncoffee tradables sector,

LP_C = logarithm of the price of coffee relative to the price of noncoffee tradables,

LP_N = logarithm of the price of nontradables over noncoffee tradables, and

$LKVA_j$ = log of real value added in sector j (j = C, T, and N).

The results of estimation are presented in Table 24. Equations 1 and 2 in the table measure the effects of changes in the relative price of coffee and nontraded goods on nonlabor income in the nontraded sector. Equations 3 and 4 measure the effects of the same relative price changes on nonlabor income in the coffee sector. Finally, equations 5 and 6 measure the effects of relative price changes on nonlabor income in the noncoffee traded sector.

The results of the regressions in Table 24 support the hypothesis that absolute returns to capital in the nontraded sector decrease with increases in the price of coffee,

Table 24—Estimated effects of relative price changes on nonlabor income in the coffee, noncoffee tradable, and nontraded sectors, 1970-82

Nonlabor Income in Sector/Period	Constant	LP_C			LP_N		Real Value Added			Adjusted R^2	Autocorrelation	Durbin-Watson Statistic
		t	t−1	t−2	t	t−1	Nontraded	Coffee t−1	Noncoffee Traded			
1. Nontraded 1970-82	−0.1583 (−1.0091)	−0.0758 (−3.961)	. . .	. . .	. . .	. . .	1.1155 (43.6406)	. . .	. . .	0.994	. . .	1.359
2. Nontraded 1971-82	−2.076 (−3.589)	−0.0653 (−4.758)	. . .	. . .	. . .	. . .	1.1355 (67.009)	. . .	. . .	0.997	−0.377 (−1.13)	2.380
3. Coffee 1972-82	−7.138 (−3.912)	. . .	. . .	0.638 (2.062)	. . .	. . .	. . .	1.905 (5.743)	. . .	0.828	. . .	1.840
4. Coffee 1972-82	−8.0541 (−0.7823)	. . .	. . .	0.6829 (1.9292)	. . .	0.1958 (0.0905)	. . .	1.9076 (5.369)	. . .	0.804	. . .	1.886
5. Noncoffee traded 1972-82	−10.011 (−10.988)	. . .	. . .	. . .	1.4859 (7.8936)	. . .	. . .	. . .	1.686 (38.347)	0.993	. . .	2.338
6. Noncoffee traded 1971-82	−11.1042 (−7.524)	. . .	−0.0105 (−0.2846)	. . .	1.8201 (6.3486)	. . .	. . .	. . .	1.6013 (24.4398)	0.982	. . .	1.760

Notes: The numbers in parentheses are t-statistics. LP_C is the log of the price of coffee relative to the price of noncoffee tradables, and LP_N is the log of the price of nontradables relative to noncoffee tradables.

whereas returns to capital in the coffee sector increase when the price of coffee goes up. According to the results in Table 24, nonlabor income in the nontraded sector of the economy (equations 1 and 2) declines when there is an improvement in the country's terms of trade. These results indicate that there is probably a significant impact on nonlabor income via the spending effect, which is transmitted relatively quickly to that sector (with a one-year lag). Although significant, this effect is not very strong since a 10 percent increase in the relative price of coffee leads to a decrease of 0.7-0.8 percent in nonlabor income in the nontraded sector. For the coffee sector (equations 3 and 4), however, an increase in terms of trade has a strong effect on nonlabor income. Thus, for every 10 percent increase in the price of coffee, nonlabor income in the coffee sector increases almost 7 percent.

The effect of terms-of-trade changes on the noncoffee tradable sector is presented in equation 6 of Table 24. According to this equation, changes in the terms of trade have a negligible effect on nonlabor income in this sector. Changes in the relative price of nontraded goods and services, on the other hand, have a strong and positive effect on nonlabor income, with an elasticity higher than one. Thus, a 10 percent increase in prices of nontraded goods increases nonlabor income by about 15 percent. This indicates that the effect on labor income of an increase in the price of nontraded goods is negative in the noncoffee tradable sector. This is not, however, the case for labor income in the coffee and nontraded sectors. For the coffee sector, the estimated value of the terms of trade coefficient for nonlabor income is less than one, which indicates that labor income increases when terms of trade improve. For the nontraded sectors, the absolute income of capital falls, which means that total labor income in that sector has to rise.

One interesting point to note about the results of Table 24 is the difference in the lagged effect of changes in coffee prices on nonlabor income in the various sectors, which may be a clue to whether the variations in the price of coffee are more closely related to spending or to resource movement effects. For the nontraded sector (equations 1 and 2), the effect of an increase in the price of coffee on nonlabor income is felt in the current period, which points toward the possibility of an important expenditure effect. However, the impact of terms-of-trade changes are only felt after two years for coffee (equations 3 and 4), and after one year for noncoffee tradables (equations 5 and 6), which may point to the existence of an important resource movement effect.

One final point that should be noted in this context has to do with the issue of factor mobility. As mentioned in the analytical framework of the previous section, the effects of changes in terms of trade on income distribution depend on factor intensity and factor mobility. Some capital mobility between the nontraded and noncoffee tradable sectors, it was found, would permit terms-of-trade improvements to redistribute income toward labor in those sectors. The empirical results presented in Table 24 indicate that indeed an improvement in terms of trade tends to redistribute income toward labor in the nontraded and noncoffee tradable sectors. Therefore, it seems likely that in the short- and medium-terms, some degree of capital mobility between the nontraded and noncoffee tradable sectors of the Colombian economy exists.

Before leaving this subject, it should be stressed that the results presented above are only a first attempt at tackling the problem of measuring the effects of changes in coffee prices on the distribution of income among factors of production. Although the formal model presented here is a complete and fully specified model, it leaves growth aside. Empirical estimation solves this problem, albeit in an inadequate fashion, by incorporating value added as an explanatory variable. However, the growth of value added over time also needs an economic explanation. Thus, a more complete specification of the model, which would take into account, among other things, the interaction of factor accumulation, factor prices, and product prices is still required. But data limitations preclude this type of analysis at this stage.

Real Wages in the Agricultural Sector

Labor earnings in agriculture continue to be the lowest in the country. Because a large though declining proportion of the population still lives in rural areas, it is important to gain understanding of the factors contributing to poverty in agriculture. Therefore, since low real wages can be associated with poverty, an analysis of the factors that determine the real wage in agriculture is relevant. To the authors' knowledge no study dealing with the problem of agricultural poverty or income distribution in rural Colombia has approached this problem in the way it is analyzed in this report.

In Colombia, as in many developing countries, urban unemployment coexists with a relatively high real wage in manufacturing, as well as with a more competitive and informal urban labor market. Despite relatively high and rising rates of urban unemployment, there has been a continuous flow of labor from agriculture to the urban sector. Given that these conditions have persisted since World War II, elements of the Todaro model are incorporated in the analysis of real wage determination in agriculture.[60]

People migrate to the city with the expectation of getting a higher-paying urban job. To some extent, the probability of succeeding will depend on the extent of urban unemployment. Thus, one can postulate that the higher the rate of urban unemployment the lower the probability of finding a well-paid job in the urban sector. The lower the probability of getting an urban job, the lower the expected urban wage and the expected gains from migration, and the higher the supply of labor in the rural sector, relative to what it would be otherwise. The Todaro model assumes that the expected urban wage is equal to the average wage of the urban employed and unemployed combined; the weights are the proportions of employed and unemployed in the urban labor force. Equilibrium in the model is attained when the agricultural wage is equal to the expected urban wage. Thus, two elements that will affect the level of real wages in agriculture are the rate of urban unemployment and the real urban wage. Another element that will affect rural real wages is the size of the rural population. The real wage rate in agriculture, the size of the rural population, the rate of urban unemployment, and real urban wages are the factors that affect the supply side of the agricultural labor market.

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[60] The issue of migration and its determinants in Colombia has been the subject of considerable attention. See, among others, William McGreevy, "Causas de la Migración Interna en Colombia," in *Empleo y Desempleo en Colombia* (Bogotá: CEDE, 1968); T. Paul Schultz, *Population Growth and Internal Migration in Colombia* (Santa Monica, Cal.: Rand Corporation, 1969); T. Paul Schultz, *Internal Migration in Colombia: A Quantitative Analysis* (Santa Monica, Cal.: Rand Corporation, n.d.); T. Paul Schultz, "La Modernización del Sector Agropecuario y la Migración Rural Urbana en Colombia," *Revista de Planeación y Desarrollo* (October 1971); Colombia, Ministerio del Trabajo, Servicio Nacional de Empleo, *La Dinámica Interna de los Movimientos Migratorios en Colombia* (Bogotá: Ministerio del Trabajo, 1979); Colombia, Departamento Administrativo Nacional de Estadística, "La Migración Interna y el Proceso de Concentración de la Población en los Departamentos," *Boletín Mensual de Estadística* (No. 314, 1977); Myriam Ordoñez, "Migración y Desempleo en las Ciudades Colombianas," in *Empleo y Desempleo* (Bogotá: Asociación Nacional de Instituciones Financieras, 1977); A. Reyes, *Efectos de la Migración Rural Urbana sobre el Desarrollo Económico y Demográfico* (Bogotá: Corporación Centro Regional de Población, 1975); Gary S. Fields, "Lifetime Migration in Colombia: Tests of the Expected Income Hypothesis," *Population and Development Review* 5 (June 1979): 247-266; and Helena Ribe, "La Posición Económica de los Migrantes y no Migrantes en Colombia," *Desarrollo y Sociedad* 5 (January 1981).

On the demand side, the real wage that agricultural producers are willing to pay will depend on the price of their output and on the productivity of labor. Thus, for a given productivity, the higher the relative price of agricultural products, the more workers agricultural producers are willing to hire. On the other hand, for a given relative price of agricultural output, the higher the productivity of labor in agriculture, the more labor services producers are willing to purchase and the higher the price they are willing to pay for them. It is well established that increases in labor productivity in agriculture have been accompanied by increases in capital in the agricultural sector. Finally, for a given relative price of agricultural output and a given productivity of agricultural labor, the lower the real wage paid in agriculture, the more labor agricultural producers are willing to employ.

Symbolically, these arguments can be presented as follows:

L^S = supply of agricultural labor,
L^D = demand for agricultural labor,
W_a = real wage in agriculture,
W_u = real urban wage (the wage at which migrants are likely to find employment),
U = urban rate of unemployment,
PA/PNA = price of agricultural output (PA) relative to the price of output in the nonagricultural sector (PNA),
N_r = size of the rural population, and
K_a = capital stock in agriculture.

The capital stock and the state of technology in agriculture determine the marginal physical product of labor in agriculture. As a result of these assumptions, then the supply of labor in agriculture is given by

$$L^S = L^S(W_a, N_r, U, W_u), \tag{42}$$

and the demand for agricultural labor is given by

$$L^D = L^D(W_a, PA/PNA, K_a). \tag{43}$$

From the previous discussion, the relationship between labor supplied and its determinants are

$$\partial L^S/\partial W_a > 0;\ (\partial L^S/\partial Nr) > 0;\ \partial L^S/\partial U > 0;\ \text{and}\ \partial L^S/\partial W_U < 0,$$

and the relationship between labor demanded and its determinants are

$$\partial L^D/\partial W_a < 0;\ \partial L^D/\partial (PA/PNA) > 0;\ \text{and}\ \partial L^D/\partial K_a > 0.$$

In equilibrium,

$$L^S(W_a, N_r, U, W_U) - L^D(W_a, PA/PNA, K_a) = 0. \qquad (44)$$

From equation (44) W_a can be derived as a function of U, W_U, PA/PNA, N_r, and K_a to obtain equation (45):

$$W_a = W_a(PN/PNA, N_r, K_a, U, W_U). \qquad (45)$$

From the signs of the partial derivatives of the supply and demand functions for labor, it results that

$$\partial W_a/\partial(PA/PNA);\ \partial W_a/\partial K_a;\ \partial W_a/\partial W_U > 0,$$

and

$$\partial Wa/\partial Nr \text{ and } \partial W_a/\partial U < 0.$$

Thus, the real wage in agriculture is a positive function of the relative price of agricultural output, of the capital stock in agriculture, and of the urban real wage, whereas it is a negative function of the size of the rural population and of the urban unemployment rate.

A description of the data used for estimating the real wage equation in the agricultural sector is presented in Appendix 1. Two rates of unemployment are used. One measures unemployment for the four major cities of Colombia (Bogotá, Medellín, Cali, and Barranquilla), using data obtained from a National Household Survey carried out by DANE. Because there is no value given for 1973, it is assumed that the value for that year is the same as for 1972. Alternatively, the regressions are run leaving that year out. The other urban unemployment rate is derived from information given by Corporación Centro Regional de Población (CCRP) on agricultural employment, total employment, and the economically active population. In this case, to derive the rate of urban unemployment, it is assumed that the economically active population in agriculture is equal to the number of people employed in agriculture. The urban rate of unemployment is then defined as the ratio of the difference between total employment and agricultural employment to the difference between the economically active population and agricultural employment.

The wage in the construction sector is taken as the real urban wage rate. The average wage of laborers in this category is derived from information on total labor remuneration from national accounts and from a series on employment for construction as supplied by CCRP. Wages for blue-collar workers in manufacturing were also used as a proxy for the opportunity cost of labor for agriculture. This, however, is not a significant variable and, as argued by Harberger, does not seem to be a relevant variable to capture the true opportunity cost of labor in the urban sector.[61]

Two sets of figures for the capital stock are used. The first approximates the capital stock using the ratio of real value added in agriculture to total employment in agriculture. This is based on the idea that the higher the capital stock, the higher the productivity of labor. The second is a measure of capital stock taken directly from Elías' study for the International Food Policy Research Institute.[62]

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[61] See A. C. Harberger, "On Measuring the Social Opportunity Cost of Labor," *International Labour Review* 103 (June 1971): 559-579.

[62] Elías, *Government Expenditures on Agriculture.*

The equation for estimating real agricultural wages is

$$\log W_a = a + \alpha \log(PA/PNA) + \beta \log K_a + \tau \log W_u + \sigma U + \lambda \log Nr + u, \qquad (46)$$

where log stands for the logarithmic value of the variable, and u is a random term.

The signs for the coefficients α, β, and τ are expected to be positive, while those for σ and λ are expected to be negative. The results of estimation, presented in Table 25, support the hypothesis about the determination of real agricultural wages. The coefficients have the expected sign, are statistically significant, and there are no problems of autocorrelation. One important result that needs to be highlighted is the one concerning the role played by relative agricultural prices. It points to a conclusion that macroeconomic policies that tend to depress agricultural prices work against the economic welfare of the rural population by reducing the real wage.

Table 25—Logarithmic regressions for estimating real agricultural wage equations

	1968-83				1968-72, 1974-83	
Coefficient	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Constant	34.4932	27.8008	230.6116	222.5885	23.8761	233.0911
	(4.097)	(3.0579)	(3.0371)	(2.4733)	(3.0532)	(2.5065)
L(PA/PNA) t	0.5395	0.5356	0.4767	0.5242	0.5213	0.5219
	(16.4295)	(13.9481)	(5.4808)	(4.8126)	(14.0870)	(4.6879)
L(K)a (T−1)	. . .	. . .	2.8655	2.6247	. . .	2.7216
			(3.8823)	(3.2511)		(3.2605)
L(VAWorker) t	1.4600	1.4056	. . .	. . .	1.3938	. . .
	(13.1061)	(11.1166)			(11.4909)	
L(RWCONS) t−1	0.2686	0.2395	0.4468	0.3521	0.2336	0.3588
	(6.1600)	(5.0309)	(2.6956)	(2.1910)	(4.9689)	(2.1816)
L (rural population)						
t	−4.2474	−3.4843	. . .	−26.8236	. . .	−28.0663
	(−4.3049)	(−3.2581)		(−2.5013)		(−2.5332)
t−1	. . .	. . .	−27.9585	. . .	−3.0412	. . .
			(−3.0689)		(−3.2808)	
Unemployment rate						
CCRP t	−0.9399	. . .	−2.9106	. . .	. . .	. . .
	(−2.8116)		(−2.4801)			
DANE t	. . .	−0.3843	. . .	−1.6548	−0.4782	−1.9157
		(1.7801)[a]		(−2.2905)	(−2.0218)	(−2.3529)
Adjusted R^2	0.995	0.992	0.958	0.952	0.993	0.053
Durbin-Watson statistic	2.29	2.30	2.04	2.04	2.516	2.23

Notes: The numbers in parentheses are t-statistics. L(PA/PNA) is the log of the price of agriculture relative to nonagriculture. L(K)a is the log of capital stock in agriculture. L(VAWorker) is the log of real value added per worker in the agricultural sector. L(RWCONS) is the log of real wages in the construction sector. CCRP corresponds to the information on unemployment derived from the Corporación Centro Regional de Población. DANE corresponds to the information on unemployment derived from the Departamento Administrativo Nacional de Estadística.

[a] Significant at 95 percent.

7

CONCLUSIONS

This report integrates the analysis of developments in Colombian agriculture between 1967 and 1983 with external developments and domestic macroeconomic policies. The analysis examines how external events and domestic policies affect the real exchange rate and relative prices in agriculture. It also looks at the effects of external terms-of-trade changes on the distribution of income between labor and nonlabor factors of production in traded and nontraded sectors, and on the determinants of real wages in agriculture. In addition, by examining the supply response of rice, cotton, wheat, coffee, livestock, and aggregate agricultural output to price changes, the importance of understanding the factors that affect the relative prices of broad aggregates of products is established. Although the report emphasizes the importance of macroeconomic policies, it should not be thought that microeconomic policies are not important for agriculture. But the success or failure of many microeconomic policies depends on the successful conduct of domestic macroeconomic policies, as well as on the adequate response of government to external shocks.

The report shows that relative prices are closely linked to developments in the international economy and to domestic economic policies. Therefore, the ability of the government to respond to changes in external circumstances or to conduct reasonable economic policies is an important element of agricultural policy broadly understood.

The first thing that comes out of the analysis in Chapter 4 is that an improvement in the terms of trade from an increase in the international price of coffee is not necessarily good for the rest of the traded sectors of the economy if this gain is not adequately offset by other policies that reduce the expenditure effect arising from the gains in terms of trade. Fiscal policy that reduces government expenditures is an obvious choice to avoid a fall in the relative price of traded goods other than coffee resulting from a coffee boom. During the 1975-77 coffee boom, this approach was tried. Central government expenditures were reduced, but not enough to avoid a decline in the relative price of noncoffee tradables. In fact, the results of Chapter 4 indicate that the size of the consolidated public sector is what matters most when looking at the effects of government expenditure on relative prices. But, as the data in Table 7 show, the size of the consolidated public sector remained more or less the same during this period.

Another obvious policy that can help avoid this decline in relative price is to tax the gains in terms of trade and to save the revenue originating in these taxes for future use. However, if the revenue from the taxation of these gains is accompanied by a corresponding increase in government expenditure, the negative impact of this policy on the relative price of noncoffee tradables will be larger than if the gains had been left entirely to coffee producers. This is so because the positive relationship found between size of government and the relative price of nontraded goods tends to support the presumption that the government's propensity to save is lower than the private sector's propensity to save. Taxation of these gains is not necessarily the only way the boom could be handled. In fact, exporters could be allowed or encouraged to leave part or all of their "above normal" revenues outside of the country while the boom lasts and to bring them into the country when the boom ends.

The decision to bring in the money or leave it out, however, would depend on the institutional arrangements in operation. At this moment in Colombia, all foreign exchange proceeds from exports have to be sold immediately to the Central Bank at a fixed exchange rate established by the government. Under this system, the initial gains of the boom go to the coffee sector because its revenue increases faster than domestic prices, and the expenditure effect occurs fairly quickly. However, under a fully flexible exchange rate system, the additional dollar revenues arising from the increase in terms of trade would have to be sold at a lower price thus leading exporters to save and retain part of their earnings abroad.

Another conclusion that emerges from the analysis presented in this report is that a tariff applied to coffee exports on the grounds of an optimum tariff argument will have the same effect as a coffee boom induced by exogenous changes in the world supply resulting from shortfalls in production in one of the major producing countries. In other words, if the optimum tariff argument for Colombian coffee is valid, that tariff will have the same effect as a coffee boom, qualitatively speaking, on the relative prices of traded goods. Moreover, as the estimated coefficients in Tables 11 and 12 indicate, the effects of terms-of-trade changes on relative prices of noncoffee traded commodities is stronger on the importable than on the exportable sector of agriculture. In this case, the more or less permanent gains for coffee arising from the imposition of an optimum tariff imply losses for the rest of the traded sector. As the promotion and diversification of exports has been a constantly stated policy goal for the last 20 years, an obvious recommendation arising from this analysis is to spend the revenues from the export tariff on coffee to compensate for or subsidize noncoffee exports by the resulting appreciation of the peso.

Also important is the confirmation of previous findings about the positive response of agricultural output to changes in prices. This point must be stressed, because the dismal performance of agriculture in the second half of the 1970s and early 1980s is attributed by many to the competition of imports. Although it is true that imports increased in the second half of the 1970s at faster rates than observed previously, they did not make large enough inroads to produce such a sharp change in the rate of growth of agricultural production. The findings on the positive response of output to price changes and the decline of relative agricultural prices in the second half of the 1970s and early 1980s largely explain the relative decline of agricultural production and the fall of agricultural exports during that period. As the results on the determination of relative prices in agriculture show, increasing government expenditure in order to reactivate the economy, as is usually argued, is not a solution to the problem of lagging agricultural growth, as such increased expenditure may reduce relative prices for agriculture.

Finally, to reduce domestic interest rates administratively in order to increase expenditure and avoid a recession in agriculture is seldom a successful policy because the interest rate is determined largely by international interest rates, the rate of devaluation, and domestic inflation. Also, administered interest rates cannot be used to change relative prices through their effect on the composition of expenditure between traded and nontraded commodities, as interest rates are mostly determined by forces that are directly out of control of the government.

The analysis of the determination of real agricultural wages shows that three elements that affect wages and that are also influenced by government policy are the terms of trade between agriculture and nonagriculture, the rate of urban unemployment, and the stock of capital in the rural sector. When an import substitution model was adopted that promoted and protected industry at the expense of agriculture, the terms of trade between agriculture and nonagriculture fell, leading to a decline in real wages in agriculture. In addition, the discouragement of capital accumulation acted against higher real wages in agriculture.

These findings have important implications for policymaking, especially when dealing with the problem of the eradication of poverty in rural areas. Several points merit consideration. First, policies that artificially depress agricultural prices tend to reduce real agricultural income and worsen rural poverty. Thus, since Colombian agriculture is mainly an exportable sector, the implementation of import substitution policies to promote industrialization does reduce the price of agricultural commodities relative to prices in the rest of the economy, and this in turn reduces real agricultural wages. The same is true for policies that reduce the price of food or subsidize imports of food products to increase the real income of the urban population. Second, because farmers do respond to prices, the accumulation of capital is discouraged when agricultural prices are artificially lowered, which reduces real wages below the level they would have been otherwise. Third, the establishment of minimum urban wages also may increase poverty in agriculture. This is because minimum wages increase urban unemployment, reduce the expected real income of the migrant, and push the supply of rural labor above what it would be otherwise, thus driving rural wages down.

APPENDIX 1: DATA SOURCES AND METHODS[63]

Prices of Traded and Nontraded Goods

The objective of constructing a price data base was to generate prices for broad categories of products including exportables and importables (called tradables) and nontraded (home) goods. To obtain relative prices, implicit price deflators for each category were generated. For this, information was needed on constant and current prices. The period covered goes from 1970 to 1983 when the information required is available.

Information for 38 agricultural products and for 70 subgroups of the industrial sector was available. No disaggregation was done for the forestry, fishing, mining, and services sectors due to time constraints. Published data from Departamento Administrativo Nacional de Estadística's (DANE), *Matrices de Insumo Producto* were used. Information at the product or group level was obtained from what are known as equilibrium worksheets in DANE's Division of National Accounts. For some periods, mainly between 1970 and 1975, the aggregation of the individual information does not match the aggregate published information in the input-output matrixes.

The following sections explain how the agricultural and industrial sectors are classified by DANE by products and groups of products, how the individual information was matched with the aggregate published information, and how the missing information was generated. For this exercise the generous collaboration of staff of DANE's Division of National Accounts was invaluable.[64]

Agricultural Sector

DANE defines the agricultural sector as the sum of sectors 01 ("pergamino" coffee), 02 (agriculture), and 03 (livestock, including dairy cattle, poultry, and other species of livestock). Sectors 08 (processed coffee) and 12 (sugar manufacturing) were added to DANE's definition of agriculture to generate what in this report is called broad agriculture (01-03,08,12).

Industrial Sector

DANE defines the industrial sector as the sum of sectors 08 to 25. In this report the industrial sector is defined as the sum of sectors 09-11 and 13-25, since 08 and 12 have been added to the agricultural sector. Due to the diversity of products manufactured in the industrial sector, information is not available by products but only at the subgroup and group levels of products.

No information is provided by DANE on the magnitude of trade in illegal drugs such as cocaine and marijuana, which explains why they are not included in this report.

Modifications to DANE's Unpublished Data

The classification here is the most disaggregated that can be found in national accounts. However, the classification system and the information varies over time as one product or group of products becomes more or less important. Moreover, in some cases the amount of disaggregation and the classification for a product or group of products are different depending upon whether the information is given in current or constant prices. For agriculture, it is necessary to aggregate various products to generate a "new" product.

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[63] This section is based on Jorge García García's "Métodologia Utilizada para Obtener Datos de Cuentas Nacionales para Industria y Agricultura," Bogotá, 1986 (mimeographed).

[64] The help of Evaristo Arrieta, Jorge Centanaro, and Néstor Carrasco, in particular, is gratefully acknowledged.

The aggregation of information from DANE's worksheets does not match exactly the published information. For the agricultural sector (01-03), matching problems are more serious because the information is published for the aggregate of sectors 01, 02, and 03. However, unpublished information for each of these sectors is available from DANE. Sector 01 is one product ("pergamino" coffee) and does not present any problems.

For some products in sector 02 (raw tobacco [02.3], cottonseed [02.7.7], and cotton fiber [02.8.1]) and in sector 03 (other animal production [03.4]) there is more than one worksheet, which means that there is more than one value for each indicator of the product. For those products the selected value is, among the various possible values, the one that minimizes the difference between the published value (or the unpublished value from DANE's input-output matrixes) and the value calculated as the aggregation of individual values. Once this first step in the cleaning process is completed, some differences still remain; to eliminate them, the procedure suggested by the DANE staff and described below was followed.

For information at current prices, the principal inconsistencies are found in the 1970-74 years, when DANE's system of national accounts began to be developed. During this period DANE made corrections to the aggregate information, but these corrections were not shifted back to the worksheets of the individual products. Corrections were then made on the products suggested by DANE's staff, but when differences still remained these were allocated proportionally among products or subgroups of products in order to maintain the initial composition within each subgroup or group.

Information at constant prices at the product level is not available in DANE's worksheets for the period 1970-74, but it can be generated from current price data using the following procedure. From the working sheets it is possible to calculate indexes of volume for each variable (output, for example) by dividing its value for year t at prices of year t – 1; that is,

$$IVOL_{t,t-1} = Q^*_t P_{t-1} / Q^*_{t-1} P_{t-1}, \tag{47}$$

where $IVOL_{t,t-1}$ is the index of volume between years t and t – 1. Defining

$$I_{(t/t-1)} = Q^*_t P_{t-1}, \tag{48}$$

and

$$I_{(t-1/t-1)} = Q^*_{t-1} P_{t-1}, \tag{49}$$

then

$$IVOL_{t,t-1} = I_{(t/t-1)} / I_{(t-1/t-1)}. \tag{50}$$

Thus, the series can be reconstructed backward if the value of the indicator for the base year, 1975, is known. Dividing the nominal value of the indicator for the year t at the price of year t – 1 by the volume index for the year t/t – 1, the absolute value of the indicator for the year t – 1 is generated. For example, if $IVOL_{(75/74)}$ is defined as the volume index between 1975 and 1974 and $I_{(75/75)}$ as the absolute value of the indicator in the base year 1975, then the absolute value of the indicator in 1974 at 1975 prices $[I_{(74/75)}]$ is defined as

$$I_{(74/75)} = I_{(75/75)}/IVOL_{(75/74)}. \qquad (51)$$

This procedure is applied to obtain the value of the indicator for each year prior to 1974. It is valid for those cases in which the value for the base year is positive, but not for those cases where it is zero. To obtain the real value for the latter, the nominal value for any year t is deflated by the price index for that product and year. A summary of the modifications to each product with data problems can be found in Jorge García García's "Metodología Utilizada para Obtener Datos de Cuentas Nacionales para Industria y Agricultura," Bogotá, 1986.

After the value for the indicator of each product is generated, differences between the sum of the values so generated and the published ones are still present. These differences are eliminated by distributing them proportionally within each group, as explained above for the nominal values.

Classification of Exportables, Importables, and Nontraded Goods

Each product or group of products is classified into one of the following categories: import-competing (MC), noncompeting imports (MNC), exportables (X), and nontraded goods (N). To classify each product in one of these categories, a statistic T is computed.[65] This statistic is defined as

$$T = (\text{Consumption-Production})/\text{Consumption}, \qquad (52)$$

where

$$\text{Consumption} = \text{Production} + \text{Imports c.i.f.} - \text{Exports f.o.b.} \qquad (53)$$

Production is measured at producer prices. Each product is classified according to the following general criteria:

$$T < 0, \text{ exportable (X)} \qquad (54)$$

$$T = 0, \text{ nontraded (N)}, \qquad (55)$$

$$0 < T \leq 0.4, \text{ import-competing (MC), and} \qquad (56)$$

$$0.4 < T \leq 1, \text{ noncompeting imports (MNC).} \qquad (57)$$

In addition to the above criteria, some other considerations are used to classify a commodity in a certain category. For example, in DANE's national accounts classification, coffee is divided into two groups: pergamino or unwashed (group 01) and processed or washed (group 08). The value of T for pergamino coffee is zero because pergamino coffee is not sold abroad, but it is very high for processed coffee. However, the domestic price of pergamino coffee is influenced by the international price of coffee, and for that reason pergamino coffee is classified as an exportable. In cases where the volume of gross and net trade is small and T is close to zero but without any defined pattern over the period, the products are classified as nontraded. In other cases, where T = 0 and imports of commodities are not registered but clear evidence of smuggling is present, the commodities are classified as import-competing or noncompeting imports (for example, television sets, transistor radios, cameras, and similar products fall in this category). Finally, in cases where T = 0 but there is clear evidence that industries cannot survive without the imposition of quota restrictions or extremely high tariffs (cars and other transport equipment, for example), the commodities are classified as noncompeting imports.

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[65] This statistic is used in Anne O. Krueger, ed., *Trade and Employment in Developing Countries: Vol. 1 Individual Studies,* for the National Bureau of Economic Research (Chicago: University of Chicago Press, 1981), p. 17; and Anne O. Krueger, *Trade and Employment in Developing Countries: Vol. 3 Synthesis and Conclusions,* for the National Bureau of Economic Research (Chicago: University of Chicago Press, 1983), p. 89. The first one to use this classification for Colombia was Francisco E. Thoumi, "International Trade Strategies, Employment and Income Distribution in Colombia," in *Trade and Employment in Developing Countries: Vol. 1 Individual Studies,* ed. Anne O. Krueger (Chicago: University of Chicago Press, 1981), pp. 135-179.

The above procedure generates categories of exportables, importables, and nontraded goods for the period 1970-83. Using a different method, information on prices for these categories is generated for the period 1967-69. Based on knowledge gained from the exercise for the period 1970-83, most of the industrial sector is identified as importable, most of the agricultural and mining sectors are identified as exportable, and most of the services sector is identified as nontraded. Because the information available from Banco de la República for this period does not lend itself to the above method, the industrial sector is taken as the importable sector, most of agriculture and the whole of mining as the exportable sector, and services as the nontraded sector. The set of relative prices generated for the importable, exportable, and nontraded sectors for the period 1967-69 corresponds to prices of value added, while that generated for the 1970-83 period refers to prices for gross value of output.

To generate prices for 1967-69 for tradable, noncoffee tradable, coffee, and nontraded categories in agriculture, information on output and prices from Banco de la República's national accounts is used, keeping in mind that the constant price series from Banco de la Républica valued at 1958 prices has to be converted to 1975 prices.

The price of pergamino coffee as supplied by Banco de la República converted to a 1975 base is used, 1970 being the common year to bridge the gap in the series. The coffee price for the series at 1975 prices corresponds to the price of pergamino and processed coffee combined (01 + 08). For noncoffee tradables in agriculture, the value of output corresponds to the difference between the value of output for the main agricultural products plus livestock minus the value for coffee output. The group called "other products" by Banco de la República is classified as nontraded.

Tables 26, 27, and 28 present the classifications adopted for each product, subgroup, or group of products from DANE's national accounts classification for agriculture, industry, and the rest of the sectors of the economy.

Data and Sources for Other Variables

Value Added

Nominal and real value added and nominal labor remuneration for each individual product in agriculture or each subgroup in industry are obtained assuming that the relationship between value added and gross value of output for each individual product is equal to the relation between value added and gross output for the sector producing that product. Total real labor remuneration by sector is found by multiplying the share of labor in nominal value added by real value added in each sector because DANE's national accounts do not provide the information in real terms.

Table 26—Classification of agricultural products by categories: food and nonfood, traded and nontraded, 1970-82

Category	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
01 Pergamino coffee	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF
02.1 Cereals													
02.1.1 Wheat	MNCF	MNCF	MNCF	MNCF	MNCF	MNCF	MNCF	MNCF	MNCF	MNCF	MNCF	MNCF	MNCF
02.1.2 Corn	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
02.1.3 Barley	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
02.1.4 Rice	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF
02.1.5 Sorghum	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
02.1.6 Oats	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
02.2 Sugarcane													
02.2.1 Sugarcane (sugar)	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF
02.2.2 Sugarcane (brown sugar)	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
02.3 Raw tobacco	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF
02.4 Tubers													
02.4.1 Potatoes	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
02.4.2 Cassava	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
02.4.3 Yams	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
02.4.4 Other tubers	NF	NF	NF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF
02.5 Vegetables and legumes													
02.5.1 Tomatoes	NF	NF	NF	NF	NF	NF	NF	XF	XF	XF	XF	XF	XF
02.5.2 Other vegetables	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
02.5.3 Red beans	NF	NF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	MF
02.5.4 Beans	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
02.5.5 Other	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
02.6 Fruit													
02.6.1 Bananas													
02.6.1.1 Bananas for export	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF
02.6.1.2 Bananas for internal consumption	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
02.6.2 Other fruit	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
02.7 Oil products													
02.7.1 Soybeans	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
02.7.2 Peanuts, coconuts, copra	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
02.7.5 Sesame	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF
02.7.6 African palm	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
02.7.7 Cottonseed	NF	NF	XF	XF	XF	XF	XF	XF	XF	MF	MF	MF	MF
02.8 Fiber													
02.8.1 Cotton	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF
02.8.2 Jute	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF
02.9 Other agricultural products													
02.9.1 Plantains	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF

(continued)

Table 26—Continued

02.9.2 Cocoa	MF	MF	MF	MF	MF	MF	MF	MF	NF	NF	NF	NF	MF
02.9.3 Flowers, rubber, other	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF	XNF
02.10 Plantation development	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF	NNF
03 Animal production													
03.1 Cattle													
03.1.1 Beef cattle	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF
03.1.2 Pigs	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
03.1.3 Other animals	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF
03.2 Poultry	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
03.3 Milk	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF	MF
03.4 Other animal products													
03.4.1 Eggs	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF	NF
03.4.2 Wool	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF	MNF
08 Processed coffee	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF
12 Sugar	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF	XF

Sources: National accounts classification from Colombia, Departamento Administrativo Nacional de Estadística, Division de Cuentas Nacionales, "Metodologia de las Cuentas Nacionales de Colombia—Segun el Nuevo SCN (Version Preliminar)," Bogotá, January 1979 (mimeographed); the classification by traded and nontraded goods is from Jorge García García, "Metodologia Utilizada para Obtener Datos de Cuentas Nacionales para Industria y Agricultura," Bogotá, 1986 (mimeographed).

Notes: XNF is exportable nonfood. MNCF is noncompeting food imports. MF is importable food. XF is exportable food. NF is nontraded food. MNF is importable nonfood.

Table 27—Classification of processed and industrial products by categories: traded and nontraded, 1970-82

Category	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
9 Meat													
1 Meat	X	X	X	X	X	X	X	X	X	X	X	X	X
2 Processed meat	M	M	M	M	M	M	M	M	M	M	M	M	M
3 Fish products	X	X	X	X	X	X	X	X	X	X	M	M	M
10 Cereal products													
1 Flour	M	M	M	M	M	M	M	M	M	M	M	M	M
2 Other milling products	X	X	X	X	X	X	X	X	X	X	X	X	N
3 Bread	N	N	N	N	N	N	N	N	N	N	N	N	N
4 Other cereals	X	X	X	X	X	X	X	X	X	X	X	X	X
5 Animal feeds	M	M	M	M	M	M	M	M	M	M	M	M	M
11 Milk products													
1 Liquid milk	M	M	M	M	M	M	M	M	M	M	M	M	M
2 Cream	X	X	X	X	X	X	X	X	X	X	X	X	X
3 Concentrated milk	M	M	M	M	M	M	M	M	M	M	M	M	M
4 Ice cream and related products	N	N	N	N	N	N	N	N	N	N	N	N	N
5 Other milk products	N	N	N	N	N	N	N	N	N	N	N	N	N
13 Beverages													
1 Nonalcoholic beverages	N	N	N	N	N	N	N	N	N	N	N	N	N
2 Beer	N	N	N	N	N	N	N	N	N	N	N	N	N
3 Wine	M	M	M	M	M	M	M	M	M	M	M	M	M
4 Other alcoholic beverages	M	M	M	M	M	M	M	M	M	M	M	M	M
5 Malt and cereal germs	M	M	M	M	M	M	M	M	M	M	M	M	M
14 Tobacco products	M	M	M	M	M	M	M	M	M	M	M	M	M
15 Other processed agricultural products													
1 Oils and margarines	M	M	M	M	M	M	M	M	M	M	M	M	M
2 Fruit and legume products	M	M	M	M	M	M	M	M	M	M	M	M	M
3 Chocolates and candies	M	M	M	M	M	M	M	M	M	X	X	X	X
4 Other foodstuffs	N	N	N	N	N	N	N	M	X	X	M	M	M
5 Dietetic products	N	M	M	M	X	X	X	X	X	X	X	X	X
16 Textiles, apparel, and leather													
1 Textiles	X	X	X	X	X	X	X	X	X	X	X	X	M
2 Handworks of textile materials	M	M	M	X	X	X	X	X	X	X	X	X	X
3 Apparel	X	X	X	X	X	X	X	X	X	X	X	X	X
4 Tanned leathers	X	X	X	X	X	X	X	X	X	X	X	X	X
5 Shoes and leather products	X	X	X	X	X	X	X	X	X	X	X	X	X
17 Wood and wood products													
1 Processed wood	X	X	X	X	X	X	X	X	X	X	X	X	X
2 Cork and wood products	M	M	X	X	X	X	X	X	X	X	X	X	X
3 Wood furniture	X	X	X	X	X	X	X	X	X	X	X	X	X
18 Paper and printing													
1 Pulps	M	M	M	M	M	M	M	M	M	M	M	M	M
2 Paper and cardboard	M	M	M	M	M	M	M	M	M	M	M	M	M
3 Paper and cardboard products	M	M	M	M	M	M	X	X	M	X	M	M	M
4 Printing and similar materials	M	M	M	M	M	M	M	X	X	M	X	X	X
19 Chemicals and rubber													
1 Base products	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
2 Fertilizers and insecticides	M	M	M	M	M	M	M	M	M	M	M	M	M

(continued)

Table 27—Continued

Category	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3 Synthetic resins and artificial fibers	M	M	M	M	M	M	M	M	M	M	M	M	M
4 Plastic products	M	M	M	M	M	M	M	M	M	M	M	M	M
5 Rubber and rubber products	M	M	M	M	M	M	M	M	M	M	M	M	M
6 Color, varnish, and lacquer	M	M	M	M	M	M	M	M	M	M	M	M	M
7 Pharmaceutical products	M	M	M	M	M	M	M	M	M	M	M	M	M
8 Toilet products	M	M	M	M	M	M	M	M	M	M	M	M	M
9 Other products	M	M	M	M	M	M	M	M	M	M	M	M	M
20 Petroleum refining	X	X	X	X	X	X	X	M	M	M	M	M	M
1 Refined petroleum	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
2 Other petroleum products	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
21 Nonmetal products													
1 Clay and porcelain objects	X	X	X	X	X	X	X	X	X	X	X	X	X
2 Glass and glass products	M	M	X	X	X	X	X	X	X	X	X	M	M
3 Other mineral non-metalic products	X	X	X	X	X	X	X	X	X	X	X	X	X
22 Base metal products													
1 Basic iron and steel products	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
2 Basic nonferrous products	M	M	M	M	M	M	M	M	M	M	M	M	M
3 Other processed products	M	M	M	M	M	M	M	M	M	M	M	M	M
23 Machinery and equipment													
1 Agricultural machinery and equipment	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
2 Machinery for metal and wood	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
3 Industrial machinery and equipment	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
4 Office equipment	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
5 Radio, TV, communications equipment	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
6 Household appliances	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
7 Electric equipment	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
8 Other equipment	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
24 Transport materials													
1 Ships and repairs	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
2 Railway equipment and repairs	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
3 Automotive vehicles	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
4 Airplanes and repairs	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
5 Other transport materials	M	M	M	M	M	M	M	M	M	M	M	M	M
25 Other manufactured													
1 Professional and scientific equipment	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
2 Optic and photographic equipment	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
3 Clocks and jewelry	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC
4 Musical instruments and others	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC	MNC

Sources: National accounts classification from Colombia, Departamento Administrativo Nacional de Estadística, Division de Cuentas Nacionales, "Metodologia de las Cuentas Nacionales de Colombia—Segun el Nuevo SCN (Version Preliminar)," Bogotá, January 1979 (mimeographed); the classification by traded and nontraded goods is from Jorge García García, "Metodologia Utilizada para Obtener Datos de Cuentas Nacionales para Industria y Agricultura," Bogotá, 1986 (mimeographed).

Notes: MNC is noncompeting importable goods. M is importable. X is exportable. N is nontraded.

Table 28—Classification of forestry, fishing, mining, and services by categories: traded and nontraded, 1970-82

Category	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
04. Forestry	X	X	X	X	X	N	N	N	N	N	N	N	N
05. Fishing and hunting	X	X	X	X	X	X	X	X	X	X	X	X	X
06. + 07. Mining	X	X	X	X	X	X	X	M	M	M	X	X	X
26. Electricity, gas, water	N	N	N	N	N	N	N	N	N	N	N	N	N
27. Construction, public works	N	N	N	N	N	N	N	N	N	N	N	N	N
28. Commerce	N	N	N	N	N	N	N	N	N	N	N	N	N
29. Transport	X	X	X	X	X	X	X	X	X	X	X	X	X
30. Communications	N	N	N	N	N	N	N	N	N	N	N	N	N
31. Banking, insurance, and other services	N	N	N	N	N	N	N	N	N	N	N	N	N
32. Housing rental	N	N	N	N	N	N	N	N	N	N	N	N	N
33. Personal services	N	N	N	N	N	N	N	N	N	N	N	N	N
34. Government services	N	N	N	N	N	N	N	N	N	N	N	N	N
35. Domestic services	N	N	N	N	N	N	N	N	N	N	N	N	N

Sources: National accounts classification from Colombia, Departamento Administrativo Nacional de Estadística, Division de Cuentas Nacionales, "Metodologia de las Cuentas Nacionales de Colombia—Segun el Nuevo SCN (Version Preliminar)," Bogotá, January 1979 (mimeographed); the classification by traded and nontraded goods is from Jorge García García, "Metodologia Utilizada para Obtener Datos de Cuentas Nacionales para Industria y Agricultura," Bogotá, 1986 (mimeographed).

Notes: M is importable. X is exportable. N is nontraded.

Real Wages and Employment

The information on real wages and employment is derived from the following sources:

From 1967 until 1982 the nominal wage for the manufacturing sector is derived from DANE, *Encuesta Anual Manufacturera* (various years), and corresponds to the blue-collar wage. To obtain real wages, three deflators are used: the implicit price of manufacturing output, the GDP deflator, and the price of noncoffee tradables. For 1983, it is assumed that the nominal wage increased by 23 percent, the rate of increase in the legal minimum wage. The information for real unit cost of labor and the index of nominal manufacturing wages are taken from Jorge García García, "The Timing and Sequencing of Trade Liberalization: The Case of Colombia Part II, The Analysis of Liberalization Episodes," a paper prepared for World Bank Research Project RPO 673-31, Bogotá, February 1986 (mimeographed) Table D.1.c.3.

The index of real agricultural wages is derived from real wages taken directly from Sociedad de Agricultores de Colombia (SAC), *Revista Nacional de Agricultura Separata,* No. 867 (June 1984), for the period 1967-82. For this set, the value for 1983 is obtained by applying the rate of growth of real agricultural wages derived from national accounts.

To obtain real wages in construction, the wage bill for the construction sector is divided by the number of people employed in the sector. The nominal wage bill is taken from Banco de la República's *Cuentas Nacionales* until 1980, and it is extended to 1981, 1982, and 1983 by applying the corresponding annual rate of growth of the wage bill for the construction and public works sector from DANE's *Cuentas Nacionales* (Sector 27). Direct information on employment in the construction sector from CCRP's Area Socioeconómica, *Modelo de Corto Plazo* is used.

The sources for DANE's urban unemployment rate are household surveys including DANE, *Encuesta de Hogares, EH-19 to EH-28;* DANE, *Colombia Estadística: 1985*

(Bogotá: DANE, 1985), Table 5.1, for 1969-83; and Centro de Estudios sobre Desarrollo Económico, *Empleo y Desempleo en Colombia* (Bogotá: CEDE, 1968) for 1967-68. The rate of urban unemployment derived from CCRP data is obtained as the ratio of the difference between total and agricultural employment to the difference between the total economically active population and agricultural employment.

Consolidated Government Expenditure and Deficit

No single source covers the period 1967-83. The sources of this information are Departamento Nacional de Planeación, Misión Bird-Wiesner, *Finanzas Intergubernamentales en Colombia* (Bogotá: Printer Colombiana, 1981), p. 26, Table II-1 for the period 1967-72; and Colombia, Departamento Nacional de Planeación, "Consolidación Financiera del Sector Público Colombiano: 1973-1982," Bogotá, September 1984 (mimeographed). For 1983 the information on consolidated government expenditure is estimated assuming that total expenditure increased 30 percent.

Interest Rates

The domestic interest rate is obtained from Gabriel Montes and Ricardo Candelo, "El Enfoque Monetario de la Balanza de Pagos: El Caso de Colombia 1968-1980," *Revista de Planeación y Desarrollo* (May-August 1982), Annex Table 1 for 1968-73; and from Patricia Correa, "Determinantes de la Cuenta de Servicios de la Balanza Cambiaria," *Ensayos sobre Política Económica* (December 1984), Annex Table 3 for 1974-83. The annual rate is obtained as an arithmetic average of the quarterly rates from these sources. The interest rate for 1967 is assumed to be equal to that of 1968.

The external rate of interest is given by the Eurodollar rate in London, which is taken from International Monetary Fund (IMF), *International Financial Statistics Yearbook 1984* (Washington, D.C.: IMF, 1984), United Kingdom page, line 60d.

The domestic real interest rate is defined as

$$r = (1 + i)/[1 + (dP/dT)(1/P)] - 1, \qquad (58)$$

where

r = real interest rate,
i = nominal interest rate,
P = implicit GDP deflator, and
$(dP/dT)(1/P)$ = percentage change in prices.

The parity interest rate is defined as

$$pr = (1 + r^*)/[1 + (dE/dT)(1/E)] - 1, \qquad (59)$$

where

pr = parity interest rate,
r^* = external interest rate,
E = nominal exchange rate, and
$(dE/dT)(1/E)$ = percentage change in the nominal exchange rate.

Money, the Monetary Base, and International Reserves

Money is defined as currency plus demand deposits, and the yearly figure is a 12-month average for each year. The monetary base is defined as currency plus reserves of the commercial banks in Banco de la República. The source of this information is Banco de la República, *Revista del Banco de la República* (various issues). The change in international reserves is derived from IMF, *International Financial Statistics: Supplement on Balance of Payments No. 7* (Washington, D.C.: IMF, 1984), p. 40. The peso value of the change in international reserves is calculated by multiplying its special drawing rights (SDR) value by the average peso exchange rate for the SDR in each year.

Physical Capital, Employment, and Land

Physical capital is taken directly from Víctor J. Elías, *Government Expenditure on Agriculture and Agricultural Growth in Latin America,* Research Report 50 (Washington, D.C.: IFPRI, 1985), Table 31. The information from Elías covers the 1967-80 period. For 1981-83 it is assumed that the rate of growth of the capital stock in agriculture is equal to the rate of growth of the capital stock for the whole economy, and the latter is taken from Jorge García García, "The Timing and Sequencing of Trade Liberalization, The Case of Colombia," Statistical Appendix to Part I (magnetic files).

Direct information on agricultural employment from CCRP's "Modelo de Corto Plazo" is used. Land used in agriculture is also taken from Elías, *Government Expenditure on Agriculture,* Table 31, for the period 1967-80. For 1981 to 1983 it comes from SAC, "Perspectivas Económicas Generales," *Revista Nacional de Agricultura* 870 (March 1985), Table 3.

Terms of Trade

The external and internal terms of trade were obtained as

TTBS = implicit price of exports of goods and services/implicit price of imports of goods and services, derived from Banco de la República, *Cuentas Nacionales* for 1967-69, and from DANE's *Cuentas Nacionales* for 1970-83.

PAPNA = implicit price of agricultural output/implicit price of output in the nonagricultural sector. This was derived from Banco de la República's *Cuentas Nacionales,* 1967-1971 for the 1967-69 period, and from DANE's *Cuentas Nacionales* for broad agriculture (01-03, 08, 12) for the 1970-83 period.

Areas, Output, and Prices

Cotton data for 1960-66 are from Jorge García García, "The Economics of Cotton Growing in Colombia," IFPRI, Washington, D.C., 1979. Those for 1967-83 are from Federación Nacional de Algodoneros, *Informe del Gerente al Congreso Nacional de Algodoneros* (Bogotá: FNA, various years).

Rice data are from Federación Nacional de Arroceros, *Un Gremio al Servicio de Colombia* (Bogotá: OP Grafica, 1985) for area, 1960-83, and for price, 1981-83. Rice prices for 1960-80 are supplied directly by Banco de la República, División de Cuentas Nacionales, Departamento de Investigaciones Económicas.

Area of wheat data for 1953-83 come from Oficina de Planeacion del Sector Agropecuario, Ministerio de Agricultura, *Estadísticas del Sector Agropecuario,* various years. Output from 1950-81 came from Banco de la República, Departamento de Investigaciones Económicas, and direct information from SAC, for 1982 and 1983. Coffee data are from Bateman, *Supply Response in the Colombia Coffee Sector,* Table 2, and livestock data are from Rivas and Valdés, "Evolución del Inventario Vacuno de Colombia," Tables A1-A5 and Appendix B.

Prices of Milk and Soybean

Milk and soybean prices for 1950-81 were supplied by Banco de la República, División de Cuentas Nacionales, Departamento de Investigaciones Económicas, for 1950-1981, and those for 1982 and 1983 came from SAC.

Finally, the additional basic Colombian data necessary for the evaluations presented in the report are given in Appendix 3, Tables 29 to 32.

APPENDIX 2:
A DEMOGRAPHIC MODEL FOR THE COLOMBIAN LIVESTOCK SECTOR: 1940-75

The demographic model used in this report to generate stocks of animals of different ages has already been applied to Colombia by Rivas and Valdés.[66]

The basis of this model is the estimation of male births of beef cattle in period t (MB_t) based on information on male slaughter in period $t + \lambda$ ($MS_{t+\lambda}$), death rates for animals younger and older than one year in period t(m_t^* and m_t, respectively), and the rate of replacement of bulls (α). Therefore, male slaughter in $t + \lambda$ can be expressed as

$$MS_{t+\lambda} = [MB_t(1 - m_t^*)(1 - m_t)^{\lambda - 1}]/(1 + \alpha), \tag{60}$$

from which is derived

$$MB_t = [MS_{t+\lambda}(1 + \alpha)]/[(1 - m_t)^{\lambda - 1}]. \tag{61}$$

Since female births are approximately 52 percent of births, female births in period t(FB_t) are

$$FB_t = 0.92\ MB_t. \tag{62}$$

The stock of male animals of each age at the end of period t is equal to the stock of animals at the end of period $t - 1$ multiplied by one minus the death rate in period t for that age category. When necessary, slaughter is deducted. Thus, the stock of male animals under a year of age in period t($MH1_t$) is given by the births in year $t - 1$ minus the deaths that take place in year t, or

$$MH1_t = MB_{t-1}(1 - m_t^*). \tag{63}$$

The stock of male animals older than one year and younger than two years at the end of period t($MH2_t$) is equal to the stock of male animals under one year in period $t - 1$ minus their deaths during year t. That is,

$$MH2_t = MH1_t(1 - m_t). \tag{64}$$

Finally the stock of male animals older than two years at the end of period t($MH3_t$) is given by

$$MH3_t = MH3_{t-1}(1 - m_t) + MH2_t(1 - m_t) - MS_t. \tag{65}$$

The total stock of male animals at the end of period t, MH_t, is given by

$$MH_t = MH1_t + MH2_t + MH3_t. \tag{66}$$

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[66] See Rivas and Valdés, "Variaciones de las Existencias de Ventas de Ganado."

For females, the procedure followed is the same. Thus, letting $FH1_t$, $FH2_t$, $FH3_t$ stand, respectively, for female herd younger than one year, between one and two years, and two and three years of age at the end of period t, then

$$FH1_t = FB_{t-1}(1 - m_t^*), \tag{67}$$

$$FH2_t = FH1_t(1 - m_t), \text{ and} \tag{68}$$

$$FH3_t = FH2_t(1 - m_t). \tag{69}$$

The herd of female animals older than three years is calculated from the total number of births and slaughter as

$$FH4_t = [(MB_t + FB_t)(1 - m_t)]/N_t - FS_t, \tag{70}$$

where N_t is the birth rate and FS_t is female slaughter during year t. The reader should note that it has been assumed that slaughter comes from the categories of males older than two years and females older than three years. Total female herd and total herd at the end of period t are given by

$$FH_t = FH1_t + FH2_t + FH3_t + FH4_t, \text{ and} \tag{71}$$

$$TH_t = MH_t + FH_t. \tag{72}$$

The birth and death rates are calculated as

$$N_t = 0.40 + 0.0756 \log_{10} t, \tag{73}$$

$$m_t = 0.05 - 0.00756 \log_{10} t, \text{ and} \tag{74}$$

$$m_t^* = 0.12 - 0.03025 \log_{10} t. \tag{75}$$

The choice of these functions is based on empirical evidence about birth and death rates for two benchmark years, 1940 and 1960.[67] Thus, N_{1940}, m_{1940}, and m^*_{1940} are equal to 0.40, 0.05, and 0.12, respectively; and N_{1960}, m_{1960}, and m^*_{1960} are equal to 0.50, 0.04, and 0.08.

With respect to the other parameters, α and λ, it is assumed that the rate of replacement for bulls (α) is 2 percent per year and the average age of male slaughter is five years for the 1940-66 period and four years for the 1967-75 period.

The figures for male slaughter correspond to those for official or registered slaughter. Total slaughter figures incorporate exports of live animals as well as slaughtered animals. As long as illegal exports and nonregistered slaughter occur, the data for births and stocks will be underestimated. Because it is impossible to determine the size of this unregistered activity, it is better to err on the low side.[68] Thus, these assumptions tend to underestimate the total cattle herd of Colombia for any given year.

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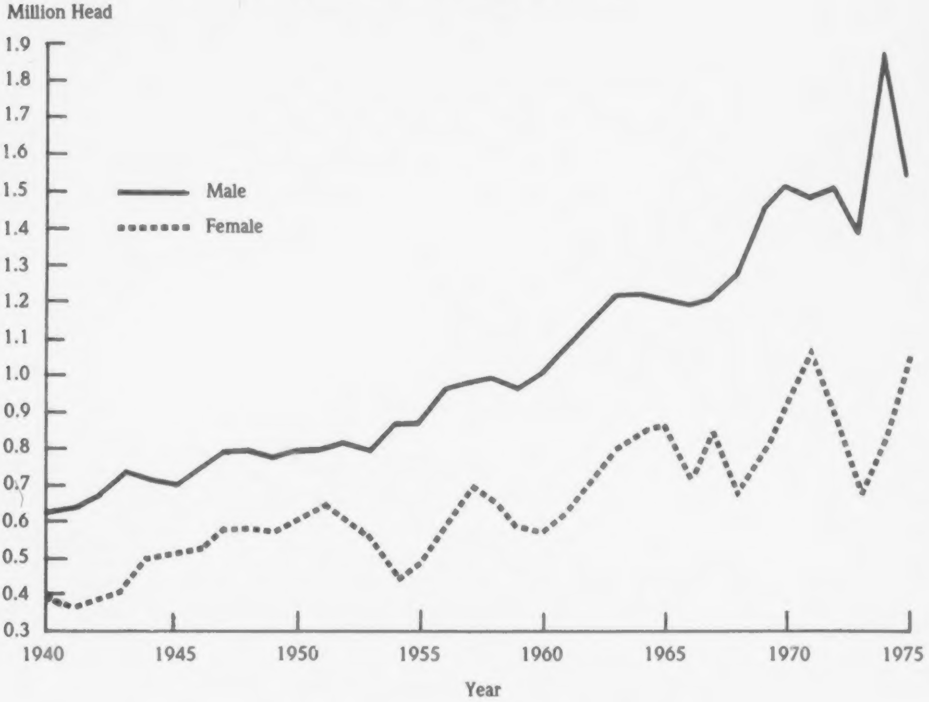
[67] Ibid. The reader will find a more detailed explanation for the selection of these two functions in the paper by Rivas and Valdés.

The behavior of sales (slaughter plus exports) and the stock of animals by male and female categories from 1940 to 1975 are shown in Figures 7 and 8. It can be seen that sales increased steadily while the herd experienced substantial increases during the 1950s and 1960s; in the 1970s the size of the herd began to decline, although sales were still rising.

Figure 7—Sales of male and female cattle, 1940-75



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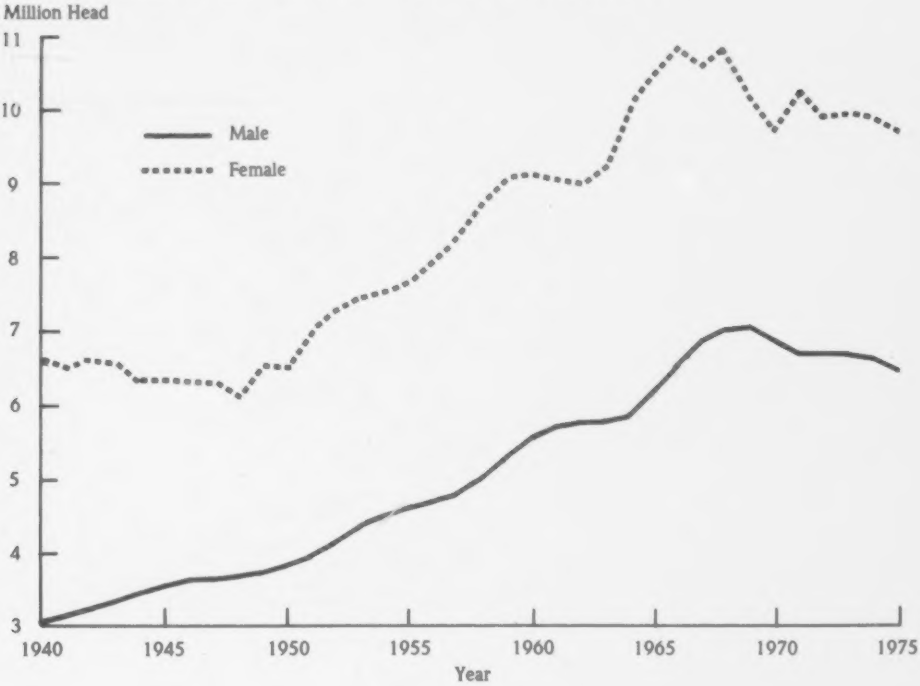
[68] Kalmanovitz's data are perhaps the first attempt to build an annual series for Colombian cattle stock, but his series suffer from serious shortcomings. He assumes that nonregistered slaughter is 10 percent of registered slaughter, without offering a justification for his choice of this value. His figures for illegal exports vary arbitrarily from year to year without sound economic reasons being given for such changes. Death and birth rates also vary arbitrarily from year to year, sometimes by large percentages. The birthrate is half the one used in this study, and he assumes the same death rate for calves and mature animals, which is clearly in contradiction with the evidence. See Salomon Kalmanovitz, *Desarrollo de la Agricultura en Colombia* (Bogotá: Editorial la Carrera, 1978), pp. 121-136. The estimates in this report are closer to those presented by Luis A. Vasquez, "Comercio Exterior de Ganado y Carne en Colombia," in *Primer Foro Nacional Ganadero* (Bogotá: FADEGAN, 1978), Tables 2 and 3.

Figure 8—Size of male and female cattle herd, 1940-75



APPENDIX 3:
SUPPLEMENTARY TABLES

Table 29—Value-added and labor income by categories of importable, exportable, and nontraded sectors, 1970-82

Category	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
							(P million 1970)						
Real value added													
Importables	40,098	43,766	48,012	49,745	54,652	54,490	56,749	69,531	73,090	76,512	71,829	72,802	78,536
Exportables	100,701	105,133	115,992	124,051	128,340	130,664	135,420	129,407	142,202	151,289	161,545	162,741	152,806
Coffee	19,326	18,949	19,943	20,232	20,736	22,724	21,126	20,745	27,352	32,306	33,180	32,147	30,980
Noncoffee	81,375	86,184	96,049	103,819	107,604	107,940	114,294	108,662	114,850	118,984	128,365	130,595	121,826
Noncoffee tradable	121,472	129,950	144,061	153,564	162,256	162.429	171,043	178,193	187,940	195,496	200,194	203,396	200,362
Nontradables	160,492	173,279	183,862	197,939	210,374	218,794	229,812	241,274	258,740	270,715	284,863	296,595	305,448
Total	301,291	322,177	347,866	371,735	393,365	403,948	421,981	440,212	474,032	498,516	518,237	532,138	536,791
Labor income													
Importables	15,560	17,271	18,242	18,035	17,668	19,347	20,155	24,693	27,767	30,118	30,833	31,790	35,004
Exportables	32,599	34,671	37,404	37,716	39,416	40,824	41,799	40,669	51,720	58,307	60,068	65,775	60,444
Coffee	3,747	3,563	3,679	3,210	3,741	3,508	3,039	3,602	6,274	8,848	8,464	11,978	10,171
Noncoffee	28,814	30,685	33,484	34,855	35,364	37,316	40,817	40,101	46,969	49,517	51,523	53,488	49,639
Nontradables	71,573	78,874	83,280	86,212	88,154	92,463	94,984	101,849	117,706	127,348	136,046	146,113	151,055
Total	113,575	121,589	131,289	138,448	145,578	152,635	162,812	172,206	189,097	199,701	215,710	220,839	225,157
Labor income													
Importables	6,737	8,092	9,440	11,562	15,114	19,347	24,662	35,381	47,691	64,691	77,243	100,578	136,895
Exportables	13,921	16,067	20,023	24,656	31,400	40,824	55,813	73,986	101,175	133,425	183,735	228,609	269,701
Coffee	1,581	1,432	1,824	2,303	2,679	3,508	5,910	11,455	16,079	20,501	25,451	30,782	33,659
Noncoffee	12,339	14,636	18,199	22,353	28,721	37,316	49,903	62,531	85,095	112,924	158,284	197,828	236,041
Nontradables	30,762	37,395	44,540	55,283	72,879	92,463	116,160	153,789	208,939	283,805	390,274	512,440	668,298
Total	51,420	61,554	74,002	91,501	119,392	152,634	196,635	263,157	357,804	481,920	651,251	841,628	1,074,894

Source: Derived from Colombia, Departamento Administrativo Nacional de Estadística, *Cuentas Nacionales de Colombia, 1970-1983* (Bogotá: DANE, 1984); and working sheets for 1970-83 provided by DANE, División de Cuentas Nacionales.

Table 30—Index of prices of gross value of output relative to prices of nontraded output, 1970-83

Category	1970	1971	1972	1973	1974	1976	1977	1978	1979	1980	1981	1982	1983
(1975 = 100)													
Relative price of tradables	95.00	92.21	93.98	98.83	102.49	106.17	109.23	103.20	97.54	100.20	96.14	95.46	95.40
Noncoffee tradables	93.06	92.14	93.09	96.79	102.39	101.36	100.72	97.70	95.61	98.99	97.71	97.04	97.38
Importables	96.07	92.38	90.52	95.80	103.78	100.88	100.48	97.75	96.12	96.89	98.32	95.25	95.29
Exportables	94.45	92.12	95.83	100.44	101.75	109.00	114.89	106.67	98.42	102.11	94.87	95.60	95.49
Coffee exportables	109.78	92.82	101.69	117.34	103.40	152.60	201.83	149.06	111.67	108.91	83.86	83.02	81.05
Noncoffee exportables	91.20	91.99	94.73	97.42	101.46	101.65	100.90	97.65	95.21	100.50	97.27	98.55	99.45
Agricultural noncoffee exportables	81.73	81.52	87.95	97.86	110.02	101.76	109.94	102.14	94.26	93.23	89.35	88.88	90.07
Agricultural tradables	94.64	87.46	93.52	105.61	106.93	119.10	138.22	118.05	100.33	98.74	86.73	86.10	85.98
Agricultural noncoffee tradables	85.45	84.37	89.09	99.21	108.78	101.50	107.13	98.11	92.05	91.49	88.59	88.03	89.26
Nonagricultural exportables	94.38	95.41	97.00	97.27	98.64	101.62	98.09	96.25	95.51	102.83	99.87	101.94	102.94

Sources: Derived from Colombia, Departamento Administrativo Nacional de Estadística (DANE), *Cuentas Nacionales de Colombia, 1970-1983* (Bogotá: DANE, 1984); and worksheets provided by DANE, Division de Cuentas Nacionales.

Note: For an explanation of the derivation of these data, see Appendix 1.

Table 31—Index of wages, 1967-83

Year	Nominal Wages: Manufacturing	Nominal Wages: Agriculture	Nominal Wages: Construction	Real Wages: Unit Cost of Labor: Manufacturing	Real Wages: Unit Cost of Labor: Agriculture	Real Wages: Unit Cost of Labor: Construction
	(1975 = 100)					
1967	32.22	30.43	20.04	99.07	91.95	60.54
1968	34.77	32.29	23.62	101.27	89.21	65.25
1969	39.34	37.18	28.17	106.04	94.96	71.93
1970	46.05	39.72	34.63	113.35	91.99	80.21
1971	51.87	44.41	42.62	115.58	92.83	89.08
1972	59.08	49.98	47.32	116.05	92.47	87.55
1973	66.08	60.01	58.92	106.80	92.39	90.73
1974	81.01	83.95	77.76	98.27	103.10	95.49
1976	126.49	114.61	93.31	105.34	91.36	78.36
1977	160.70	175.69	125.65	107.43	108.43	77.54
1978	218.86	227.67	164.07	122.97	119.99	86.47
1979	273.53	285.14	221.52	123.20	121.16	94.12
1980	354.41	366.54	281.62	123.86	122.04	93.76
1981	456.87	457.22	360.63	129.56	124.00	97.81
1982	624.25	528.57	450.06	140.36	114.89	97.83
1983	767.83	630.31	551.91	n.a.	112.63	98.63

Sources: Derived from Colombia, Departamento Administrativo Nacional de Estadística, *Encuesta Manufacturera*, various issues; Sociedad de Agricultores de Colombia, *Revista Nacional de Agricultura Separata*, 867 (June 1984).

Note: For an explanation of the derivation of these data, see Appendix 1.

Table 32—Population, employment by sector, economically active population, and rate of unemployment, 1965-83

Year	Population: Rural	Population: Urban	Population: Total	Employment: Agriculture	Employment: Urban	Employment: Total	Economically Active Population (EAP): Total	Economically Active Population (EAP): Urban	Unemployment Rate in Urban Sector
				(1,000 persons)					(percent)
1965	8,806.7	9,926.4	18,733.1	2,622.6	2,600.2	5,222.8	5,520.2	2,897.6	10
1966	8,885.7	10,377.0	19,262.7	2,643.5	2,718.3	5,361.8	5,698.5	3,055.0	11
1967	8,962.4	10,831.7	19,794.1	2,663.6	2,820.1	5,483.7	5,879.6	3,216.0	12
1968	9,042.2	11,286.5	20,328.7	2,684.6	2,977.8	5,662.4	6,063.8	3,379.2	12
1969	9,117.2	11,734.6	20,851.8	2,705.1	3,165.0	5,870.1	6,248.9	3,543.8	11
1970	9,184.6	12,179.5	21,364.1	2,722.4	3,340.4	6,062.8	6,431.0	3,708.6	10
1971	9,242.1	12,622.9	21,865.0	2,736.6	3,491.1	6,227.7	6,613.1	3,876.5	10
1972	9,290.9	13,062.8	22,353.7	2,748.3	3,666.9	6,415.2	6,793.8	4,045.5	9
1973	9,332.3	13,497.7	22,830.0	2,757.7	3,720.1	6,477.8	6,973.0	4,215.3	12
1974	9,378.0	13,895.0	23,273.0	2,789.9	3,866.7	6,656.6	7,165.5	4,375.6	12
1975	9,421.0	14,303.0	23,724.0	2,821.6	4,136.7	6,958.3	7,480.1	4,658.5	11
1976	9,462.0	14,723.0	24,185.0	2,852.8	4,432.4	7,285.2	7,799.7	4,946.9	10
1977	9,498.0	15,156.0	24,654.0	2,883.6	4,676.0	7,559.6	8,047.2	5,163.6	9
1978	9,530.0	15,602.0	25,132.0	2,912.4	4,992.6	7,905.0	8,345.0	5,432.6	8
1979	9,560.0	16,060.0	25,620.0	2,941.6	5,246.7	8,188.3	8,713.6	5,772.0	9
1980	9,585.0	16,532.0	26,117.0	2,969.5	5,570.6	8,540.1	9,159.0	6,189.5	10
1981	9,605.0	17,018.0	26,623.0	2,995.8	5,671.2	8,667.0	9,207.4	6,211.6	9
1982	9,622.0	17,518.0	27,140.0	3,021.3	5,904.3	8,925.6	9,531.0	6,509.7	9
1983	9,633.0	18,033.0	27,666.0	3,045.0	6,039.3	9,084.3	9,830.8	6,785.8	11

Sources: Corporación Centro Regional de Población, "Area Socio-Econômica: Modelo de Corto Plazo," unpublished data.

Notes: Rate of unemployment is derived from the following equation:

(Total employment − Agricultural employment)/(EAP − Agricultural employment).

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